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AUSTRALIAN AMPHIBIA IN THE MUSEUM OF COMPARATIVE ZOÖLOGY CAMBRIDGE, MASSACHUSETTS

By Arthur Loveridge

With One Plate

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No. 1.—*Australian Amphibia in the Museum of Comparative Zoölogy, Cambridge, Massachusetts*

By Arthur Loveridge

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Introduction

The arrival in January, 1933, of the third and final consignment of amphibia collected by the recent Harvard Expedition to Australia brings the total number of specimens collected by the Expedition to 581, representing 45 species of which 4 were new to science and have been described elsewhere[1]. In addition, and as a direct result of this study, a new genus and three new species have been described[2] based on material collected by Mr. L. Glauert of Perth and Dr. F. N. Blanchard of Michigan.

The necessity of identifying the Harvard Expedition material involved a thorough reëxamination of all earlier Australian accessions to the Museum collection, and an intensive study of the status of many recently described species. It revealed that the Museum now possesses all of the 20 genera inhabiting Australia, and 78 of the 88 species or races.

In view of the relative comprehensiveness of this material the present paper has been written with a view to placing at the disposal of our Australian colleagues, who rendered such generous assistance to the Harvard party during the expedition, the wealth of locality data which would otherwise remain inaccessible to them among the records of our card-index cabinets. Moreover, the study of this material has resulted in a clearer conception of the status of many species and involves numerous changes in taxonomy which are referred to below.

[1] Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, pp. 55–60.
[2] Loveridge, 1933, *ibid.*, pp. 89–94.

History of the Collections

The earliest material from the Australian Continent to reach the Museum, consisted of 11 specimens, representing 3 species, but without precise locality. Shortly afterwards a small exchange was arranged with Prof. W. Keferstein of the Göttingen Museum. It is characteristic of the vagueness of locality data at that time in that most of the specimens were simply labelled New South Wales.

In 1885, a second collection from the same source brought the total of this historical Göttingen material up to 28, and included what is almost certainly a cotype of Keferstein's *Pseudophryne coriacea*.

Then followed a long period of stagnation in so far as the development of the collection of Australian amphibia was concerned. Small lots, totalling 18 specimens in all but with a high proportion of species, were purchased from Prof. F. Müller, H. A. Ward, and W. F. H. Rosenberg; those from the latter being presented by Dr. Thomas Barbour more recently.

During the earlier part of this period, however, Mr. E. A. C. Olive and Dr. W. M. Woodworth of the Harvard Great Barrier Reef Expedition of 1896, brought back 5 frogs from Cooktown, Port Bowen, and Townsville. These were reported upon by Garman (1901, p. 14).

In 1913 (and again in 1929–1930) my colleague Dr. H. L. Clark, who was collecting echinoderms off the tropical northern coasts of Australia, returned with 16 specimens of which 2 represented species (*Hyla dayi* and *Sphenophryne polysticta*) new to the Museum. The earlier collection was reported upon by Barbour (1914, p. 201).

The following year, 1914, Dr. Thomas Barbour arranged an exchange with the Australian Museum, Sydney, which added 48 frogs representing many species of which no less than 20 were entirely new to the Museum collection. This material has proved of the greatest assistance to me during my present studies. In the same year 2 frogs were received from the Queensland Museum and 5 others from Mr. T. Steel. These were referable to 4 species all new to the collection here; one was a *Hyla blandsuttoni* Procter, a species which at that time was confused with *aurea* (Lesson).

In 1914, Prof. W. M. Wheeler collected and presented 4 examples of the then recently described *Phrynomantis ornata* (Fry), which proved another welcome addition.

Late in the year 1926, Mr. W. S. Brooks, curator of Birds' Eggs, visited Western Australia. In the early part of 1927 he visited the southwest corner of the continent and added 571 amphibia, represent-

ing 7 species of which 4 were new to the collection and 1 of these new to science—*Pseudophryne brooksi*. This constituted the first extensive amount of material to reach the Museum and included good series of such choice things as *Crinia leai* Fletcher and *Pseudophryne nichollsi* Harrison, the latter only described that year (1927).

The receipt of this collection stimulated some further interest and in 1929 led to exchanges with several museums—British, Royal Swedish, and Michigan University Museum of Zoölogy. Two additional species resulted and also a paratype of *Phrynixalus reginae* Andersson.

One of the first results of the arrival of the Harvard party in Western Australia in 1931 was the receipt of 143 amphibia from Prof. G. E. Nicholls. These represented 11 species of which 4 were new to the Museum, including such fine things as Western Australian examples of *Pseudophryne australis*, and *Myobatrachus gouldii*.

The Harvard Australian Expedition of 1931–1932, consisting of Professor W. M. Wheeler, Dr. Glover M. Allen, Dr. P. J. Darlington, Messrs. W. E. Schevill and R. Ellis, proceeded to Western Australia where they collected during the latter part of 1931. The material resulting from their joint efforts was labelled "Harvard Expedition" and so appears in the following pages. Toward the close of the year the senior members returned to the United States and the party split up, Dr. Darlington collecting from Sydney northwards to Cape York, and Schevill through New South Wales, Queensland and that portion of the Northern Territory formerly known as Central Australia. The material secured in 1932 bears the name of one or another of these gentlemen.

It should be remembered that the collecting of amphibia formed but a minor activity of the party, yet in all 581 frogs were secured. Eleven of the 45 forms collected were species hitherto unrepresented in the Museum and included such rarities as *Philoria frosti, Lechriodus fletcheri, Crinia acutirostris, Crinia rosea* and *Sphenophryne gracilipes;* most, if not all of which, were only known from the types.

During the past six months, by gift or exchange, 93 specimens representing 7 forms lacking in the collection, were received from the Australian Museum, Western Australian Museum, Queen Victoria Museum at Launceston, and Dr. F. N. Blanchard. This brought the total of Australian amphibia in the collection to 1,467. This number has already been reduced by about 200 which, after study and naming, were returned to the leading Australian museums in appreciation of their coöperation with the Harvard Expedition.

Taxonomic Alterations

A few remarks on some nomenclatorial and other changes may not be amiss. Boulenger (1882) followed by Nieden (1923) referred certain Australian genera to the families Cystignathidae and Bufonidae. Later Waite (1929) substituted Ceratophriidae for the former. That such a division of the genera is unnatural is obvious if one compares Uperoleia (whose spelling was arbitrarily changed to Hyperolia by Boulenger) of the Cystignathidae with Pseudophryne of the Bufonidae. Recently Noble (1931) assembled the Australian members of both groups of genera in one subfamily, Criniinae, of the Bufonidae. However Noble merges the Leptodactylidae (= Cystignathidae, part, of Boulenger) in the Bufonidae, a course which I am not quite prepared to follow. For the present I prefer to regard the Criniinae as a subfamily of the Leptodactylidae as is done in the present paper.

Two preoccupied genera, familiar through long usage, were abandoned at the suggestion of Ogilby (1907, p. 32), these are Chiroleptes and Cryptotis, the former replaced by Phractops and Mitrolysis, the latter by Adelotus. I observe also that Fry (1914, p. 179) had already detected that Helioporus constituted the original spelling of this genus by Gray. Boulenger (1882, p. 271) misquoted Gray as spelling it Heleioporus. Though vexatious, the laws of nomenclature necessitate our returning to the original spelling. The reasons for other generic changes which I have followed will be obvious from the citations given.

The only comprehensive work dealing with Australian amphibia since the appearance of Boulenger's Catalogue of the Batrachia Salientia in the British Museum (1882), are two volumes by Nieden in Das Tierreich, **46** and **49** (1923, Anura **1**: 1926, Anura **2**).[1] Though these works are largely compilations following Boulenger, with the addition of species described in the interval, rather than based on revisionary studies, I should have liked to cite them under each species. The additional cost of printing, however, makes such a course inadvisable at the present time. Instead I have confined my citations to those of the original description and principal synonyms together with the type localities of each. The bibliography at the end of this paper has been curtailed by omitting the papers thus cited and limiting it to such papers as it has been necessary to refer to in the text. Actually many others have been consulted in addition to those listed.

[1]To these should be added Parker, 1934, "Frogs of the family Microhylidae," which was first seen after the galleys of this paper were received. It represents an authentic revision of all species.

As already indicated, these studies have led me to consider as synonyms a number of species hitherto considered valid, though doubts as to the specific distinctness of three of them have already been expressed by other workers.

The following are considered strict synonyms:

Neobatrachus pictus Peters	= *Helioporus eyrei* (Gray)
Heleioporus sudelli Lamb	= *Helioporus eyrei* (Gray
Limnodynastes olivaceus De Vis	= *Limnodynastes tasmaniensis* Günther
Crinia stolata Cope	= *Crinia signifera ignita* Cope
Crinia michaelseni Werner	= *Crinia leai* Fletcher
Pseudophryne fimbrianus Parker	= *Uperoleia marmorata* rugosa (Andersson)
Hyla luteiventris Ogilby	= *Hyla gracilenta* Peters
Hyla tympanocryptis Andersson	= *Hyla dayi* Günther
Hyla gilleni Spencer	= *Hyla caerulea* (Shaw)
Hyla serrata Andersson	= *Hyla eucnemis* Lönnberg
Hyla ewingii orientalis Fletcher	= *Hyla ewingii verreauxii* Duméril
Hyla krefftii Günther	= *Hyla jervisiensis* Duméril & Bibron
Hyla nannotis Andersson	= *Hyla obsoleta* Lönnberg
Pelodytes affinis Gray	= *Hyla lesueurii* Duméril & Bibron
Hyla nigrofrenata Günther	= *Hyla lesueurii* Duméril & Bibron
Hyla vinosa Lamb	= *Hyla lesueurii* Duméril & Bibron
Hyla tornieri Nieden	= *Hyla lesueurii* Duméril & Bibron
Hyla dimolops Cope	= *Hyla latopalmata* (Günther)
Phrynixalus reginae Andersson	= *Phrynomantis ornata* (Fry)[1]
Austrochaperina robusta Fry[2]	= *Sphenophryne polysticta* (v. Méhely)
Austrochaperina brevipes Fry	= *Sphenophryne polysticta* (v. Méhely)

The following are considered to be subspecies:

Limnodynastes peronii lineatus De Vis
Crinia signifera ignita Cope
Crinia affinis haswelli Fletcher
Crinia laevis froggatti Fletcher
Uperoleia marmorata rugosa (Andersson)

From the above it will be seen that three New Guinea species are added to the Australian fauna by their Queensland counterparts being placed in the synonymy. The species to which I refer, are:

Hyla eucnemis Lönnberg
Hyla obsoleta Lönnberg
Sphenophryne polysticta (v. Méhely)

[1] *Cophixalus ornatus* (Fry) according to Parker, 1934, p. 171.
[2] Parker, 1934, p. 157 considers *robusta* a composite, only part being a synonym of *S. polysticta*.

Among the more interesting results of this revisionary study, is the finding of Western Australian *Pseudophryne australis.* This reveals that the Sydney frog has been misnamed *australis* for nearly half a century; it should be called *albifrons* (Duméril & Bibron). The identification of the Sydney frog known as *Hyla krefftii* Günther with the older *jervisiensis* Duméril & Bibron, which in the literature of nearly a century has been known only from the type, may be questioned by some, but is, I believe, correct. Less unfortunate in its results is the finding that another Sydney frog—*Hyla dimolops* Cope—is a synonym of *H. latopalmata* (Günther).

Systematic List of Australian Amphibia

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LEPTODACTYLIDAE

Mixophyes fasciolatus fasciolatus Günther

Mixophyes fasciolatus Günther, 1864, Proc. Zoöl. Soc. London, p. 46, pl. vii, fig. 1: Clarence River, New South Wales.

Hyla fenestrata De Vis, 1884, Proc. Roy. Soc. Queensl., **1**, p. 128: Tweed River. (Boundary New South Wales & Queensland.)

* Unrepresented in the Museum of Comparative Zoölogy.

♂ ♀ (M. C. Z. 3592–3) Nambucca River, N. S. W. (Australian Mus.) 1914
2 (M. C. Z. 18147–8) Cascade, Dorrigo, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18149) Salisbury, N. S. W. (P. J. Darlington) 1932.
3 (M. C. Z. 18482–4) Bunya Mountains, Q. (W. E. Schevill) 1932.
Taken at altitudes from 1,000 to 3,000 feet.

Boulenger (1882, p. 188) states "tongue circular," this appears to be the case with some frogs but in others it is deeply notched. While in the frogs from Nambucca River and Bunya Mountains the tibio-tarsal articulation of the adpressed hind limb only reaches to the eye, in those from Cascade and Salisbury (with the exception of No. 18148, which is a 29 mm. juvenile) it extends well beyond the end of the snout; such variation is not a sexual character neither is it racial in a taxonomic sense though probably constant one way or the other in adult specimens from a given locality. Three joints of the fourth toe and at least the terminal joint of the fifth are free of web in all the above specimens, a character which I believe separates the typical form from the northern race so recently described. The largest specimen (No. 18483) measures 84 mm.

Mixophyes fasciolatus schevilli Loveridge

Mixophyes fasciolatus schevilli Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 55: Millaa Millaa, Atherton Tableland, Queensland.

3 (M. C. Z. 18150–2) Millaa Millaa, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18480) Lake Barrine, Q. (W. E. Schevill) 1932.
1 (M. C. Z. 18481) Bellenden Ker Range, Q. (W. E. Schevill) 1932.

These are the types of a northern race differentiated by two joints of the fourth toe being free of web (exclusive of a possible narrow fringe) and not even the terminal joint of the fifth toe being free of web.

Phractops dahlii (Boulenger)

Chiroleptes dahlii Boulenger, 1895, Proc. Zoöl. Soc. London, p. 867, pl. xlix, fig. 2: Daly River, Northern Territory.

2 (M. C. Z. 15576–7) Near Melbourne, V. (Michigan Mus.) 1929.

The locality on these specimens should only be accepted with the greatest reserve. On enquiry, I learn from Mrs. H. T. Gaige of the Michigan Museum that these frogs were received from a lady—Dr. G. Buchanan—resident in Melbourne and were supposedly from

that locality. I have no doubt as to their being correctly identified as *dahlii* with figure of which they are in close agreement.

From Boulenger's description these adult females differ in the following points: Snout (as from the nostril) slightly *shorter* than the diameter of the orbit; first finger longer or *shorter* than the second; fourth toe with only a very narrow fringe of web on the last joint, said to be "webbed to the tips;" the tibio-tarsal articulation of the adpressed hind limb reaches in front of the eye (No. 15577) or falls short of it (No. 15576). The larger specimen, a female (No. 15577) measures 67 mm., the type was 70 mm.

Phractops platycephalus (Günther)

Chiroleptes platycephalus Günther, 1873, Ann. Mag. Nat. Hist. (4), **11**, p. 350: Fort Bourke, New South Wales.

♂ (M. C. Z. 3581) Darling River, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 18172) ?Murchison district, W. A. (G. E. Nicholls) 1932.
8 (M. C. Z. 18173–9) Near Yalgoo, W. A. (G. E. Nicholls) 1932.

The Yalgoo specimens came from Dalgaranger Station, fifty miles to the northeast of Yalgoo.

This species is omitted from Fry's (1914, p. 198) key to the amphibia of Western Australia, but the western specimens listed above agree well with the eastern. Of the type Boulenger (1882, p. 268) stated, "tympanum indistinct;" in all our ten specimens, however, it is perfectly distinct; nor is the tongue always entire, in No. 18172 it is clearly nicked behind; the tibio-tarsal articulation of the adpressed hind limb reaches the *axilla* or *shoulder*; it is the tarso-metatarsal articulation that marks the tympanum so that Boulenger's statement would appear to constitute a *lapsus calami*. Günther makes no mention of this character. The largest specimen (No. 18172) measures 60 mm.

Phractops brevipes (Peters)

Chiroleptes brevipes Peters, 1872, Monatsber. Akad. Wiss. Berlin, 1871 (1872), p. 648: Port Bowen (Queensland).

Chiroleptes brevipalmatus Günther, 1876, Journ. Mus. Godeffroy, **5**, no. 12, p. 47: Port Denison, Gayndah, and Peak Downs, Queensland.

♂ ♀ (M. C. Z. 3585–6) Darling River, N. S. W. (Australian Mus.) 1914.

These two frogs were received as *brevipalmatus*, and doubtless constitute part of the series of eight frogs from Wilcannia, Darling River,

of which Fry (1915, p. 70) writes. It should be noted that in the amount of webbing they approximate rather to *brevipes*, though in possessing a nostril which is equidistant between the eye and end of snout they agree rather with the description of *brevipalmatus*. Judging by the descriptions these two species appear to be so closely related that I suspect that they may not be really distinct. The larger specimen (No. 3586) measures 46 mm.

Phractops australis (Gray)

Alytes australis Gray, 1842, Zoöl. Miscellany, p. 56: Port Essington, Northern Territory.

1 (M. C. Z. 3584) Cooktown, Q. (Australian Mus.) 1914.
1 (M. C. Z. 18180) Burnett River, Q. (T. L. Bancroft) 1932.
4 (M. C. Z. 18181–4) Coen, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18185) Mt. Carbine, Q. (P. J. Darlington) 1932.

Boulenger (1882, p. 268) in his key to the species of Phractops, states "snout twice as long as the greatest orbital diameter" by which he means snout as from the anterior border of the orbit, unfortunately in other keys he treats of the snout as from the nostril only. The largest specimen (No. 3584) measures 85 mm.

Mitrolysis alboguttatus (Günther)

Chiroleptes alboguttatus Günther, 1867, Ann. Mag. Nat. Hist. (3), **20**, p. 54: Port Denison and Cape York, Queensland.

♀ (M. C. Z. 3605) Eidsvold, Burnett R., Q. (Australian Mus.) 1914.
♀ (M. C. Z. 3703) Brisbane, Q. (Queensland Mus.) 1915.
1 (M. C. Z. 11647) Alexandra, N. T. (British Mus.) 1915.
1 (M. C. Z. 18529) Mt. Wilson, N. S. W. (P. J. Darlington) 1932.

Number 11647 is a young frog and was received from the British Museum as *P. australis* but, though coming from near the type locality of that species, it appears to agree rather with *alboguttatus*.

This species has been removed from Phractops (Chiroleptes is preoccupied) to Mitrolysis on account of its supposedly lacking a vertical pupil; a character which is masked in the specimens listed except No. 18529 where it is elliptically vertical. In this connection attention should be directed to Fletcher's statement (1891-2, p. 271) that in

life *P. platycephalus* and *P. australis* from Herberton have distinctly horizontal, *not* vertical pupils. This was subsequently confirmed by Spencer (1896, p. 160) for *platycephalus* only. In the few individuals of *platycephalus* in our collection in which this character is observable, they are vertical. The matter deserves the careful attention of Australian herpetologists, and the status of all the species should be reinvestigated. If *australis* has a horizontal pupil, it would appear that Cyclorana, Steindachner, 1867 (of which *australis* was the type) should take precedence over Mitrolysis, Cope, 1889 for those species having a horizontal pupil.

The length of the snout, used by Boulenger (1882, p. 268) as a key character to distinguish *alboguttatas* from *australis* (see remarks under that species) in reality fails to do so, the nostril is equidistant from the eye and the end of the snout while the diameter of the orbit is equal to the distance from the nostril to the end of the snout. Two specimens (Nos. 3605, 3703) measure 63 mm.

Helioporus albopunctatus Gray

Helioporus albopunctatus Gray, 1841, in Grey's Journ. Exped. Discov. West. Australia, **2**, p. 447, pl. 1, fig. 2: Western Australia.

♀ (M. C. Z. 3627) Western Australia (Australian Mus.) 1914.
10 (M. C. Z. 18186–95) Meckering, W. A. (G. E. Nicholls) 1931.
2 (M. C. Z. 18196–7) Geraldton, W. A. (P. J. Darlington) 1931.
11 (M. C. Z. 18203–12) Margaret River, W. A. (Harvard Exped.) 1931.
3 (M. C. Z. 18213–5) Pemberton, W. A. (Harvard Exped.) 1931.

It might be as well to state that the Margaret River where the Harvard Expedition collected was situated in the Southwest Division of Western Australia.

The frogs from Geraldton, 10. x. 31, one from Margaret River, 6. xi. 31, and Pemberton, 10-16. xi. 31, range in size from 15 to 26 mm., present an obviously juvenile appearance about the mouth and snout and some from each locality retain their tails or stumps of the same. On account of their white metatarsal tubercles I refer them to *albopunctatus*; in the adults this tubercle is rust-colored. The largest specimen (No. 18195) measures 75 mm.

While in the text the name of this species is spelled as above, the legend which appears beneath the figure on plate 1 states "*Heleioporus abboguttatus* (Gray)."

Helioporus insularis Loveridge

Helioporus insularis Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 92: Rottnest Island, Western Australia.

5 (M. C. Z. 18198–202) Rottnest Id., W. A. (P. J. Darlington) 1931.

The above are juvenile paratypes taken on October 6, 1931 and still showing stumps of tails. The island form differs in size and color from the mainland species, as was pointed out to me by Mr. L. Glauert.

Helioporus pelobatoides Werner

Heleioporus albopunctatus var. *pelobatoides* Werner, 1914, in Michaelsen & Hartmeyer's Fauna Südwest-Australien, **4**, p. 418: Beverley and Broome Hill, south Western Australia.

♂ (M. C. Z. 19430) Tambellup, W. A. (Western Australia Mus.) 1933.

Nieden (1923, p. 526) was in error in placing *pelobatoides* in the synonymy of *albopunctatus*. If our specimen is correctly determined—and Tambellup is not far from the type locality—it is undoubtedly a full species. This male, with brown rugosities on the first and second digits, shows breeding asperities like the African Megalixalus, measures 37 mm.

Helioporus eyrei (Gray)

Perialia eyrei Gray, 1845, in Eyre's Journ. Exped. Discov. Cent. Australia, **1**, p. 407, pl. ii, fig. 3: Australia, on the banks of the river Murray.

Neobatrachus pictus Peters, 1863, Monatsb. Akad. Wiss. Berlin, p. 235: Adelaide, South Australia.

Heleioporus sudelli Lamb, 1911, Ann. Queensl. Mus., No. 10, p. 26: Warwick, southern Queensland.

3 (M. C. Z. 188216–8) Mullewa, W. A. (Harvard Exped.) 1931.
1 (M. C. Z. 18219) Pindawa, W. A. (W. E. Schevill) 1931.

Pindawa is 35 miles from Mullewa.

Boulenger (1882, p. 271) referred *eyrei* to the synonymy of *albopunctatus* but gave the type locality as "W. Australia." However, as we know that Eyre travelled along the Murray River, there seems to have been no justification for this change. Presuming, therefore, that the type locality was, as stated, on the Murray River, then, as *albo-*

punctatus is unknown from South Australia, the types of *eyrei* very possibly represent the frog which was later named *pictus* by Peters.

H. pictus is a full species characterized by its small size and a black metatarsal tubercle. This tubercle is black in all four of our frogs one of which still retains its larval tail. I imagine that the frogs from Mowla Downs and seventy miles south of the Fitzroy River, which Andersson (1913, p. 16) refers to *pictus* though stating that their metatarsal tubercles are not black, are probably juvenile *albopunctatus*. Spencer (1896, p. 166) is somewhat ambiguous on this point. If the metatarsal tubercle is not always black it would be interesting to know why. Lamb (1911, p. 26) when describing *sudelli* does not mention the color of the tubercle, so that it is with some misgivings that I refer *sudelli* to the synonymy.

While the maximum size appears to be about 44 mm., our largest example (No. 18219) measures only 28 mm., and the smallest, 17 mm. A Mullewa frog, taken on 12. ix. 31, still retains its tail.

Philoria frosti Spencer

Philoria frosti Spencer, 1901, Proc. Roy. Soc. Victoria (2), **13**, p. 176: Mt. Baw Baw, Victoria.

6 (M. C. Z. 18423–5) MacPherson Range, Q. (P. J. Darlington) 1932.

This northern record from southern Queensland provides an interesting extension of range for this rather brevicipitid-like frog.

From the original description they differ in having round, not horizontal pupils; tympana, though generally hidden are occasionally distinguishable; the parotid glands are not so conspicuous as in the type nor the dorsal surface so warty as one would judge from the description. Warts are present, however, though the general appearance (probably due to immersion in water before preservation) is smooth above and below.

The following description is based on a 33 mm. female. Habit stout. Head longer than broad; snout subacuminate; the distance from the nostril to the tip of the snout is greater than its distance from the anterior border of the orbit and equals the orbital diameter; canthus rostralis rounded but distinct, loreal region concave; interorbital space slightly concave, once and a half times as broad as an upper eyelid; pupil round; anterior portion of tympanum distinct (hidden in some specimens); tongue pyriform, slightly nicked and free behind; vomerine teeth in two oblique groups, their anterior and

outer edges close behind, though not projecting beyond the choanae, their posterior edges scarcely separated on the median line of the palate; no prominent, cutaneous, palatal folds. Fingers stout, their tips undilated, the length of the first half that of the second, which equals the fourth, third the longest; two prominent, though flat, metacarpal tubercles, a third sometimes distinguishable; toes well developed, free, without web, their tips undilated, first toe about half as long as the second which equals the fifth and is about half as long as the third which is about two-thirds the length of the fourth; subarticular tubercles only slightly prominent; a small, flattened, inner metatarsal tubercle, no outer one; the tibio-tarsal articulation of the adpressed hind limb scarcely reaches the axilla in females but to the tympanum in males; the tip of the longest toe reaches just beyond the end of the snout in females. Skin smooth above though with incipient warts distinguishable; below, smooth.

Measurements of this female: Snout to anus 33 mm., fore limb from axilla 14 mm., hind limb from anus 40 mm. Measurements of a male: Snout to anus 25.5 mm., fore limb from axilla 10 mm., hind limb from anus 40 mm.

Philocryphus australiacus (Shaw)

Rana australiaca Shaw, 1795, Nat. Miscellany, **6**, pl. cc and text: Australia.
Philocryphus flavoguttatus Fletcher, 1893, Proc. Linn. Soc. N. S. W. (2), **8**, p. 233: Mt. Victoria, Blue Mountains, Cook Co., New South Wales.
Philocryphus australiacus Fry, 1915, Proc. Roy. Soc. Queensl., **27**, p. 70.

♂ (M. C. Z. 3524) Leura, N. S. W. (T. Steel) 1914.

Fry (1914, p. 206) has given reasons why Philocryphus should be retained and not merged with Helioporus as suggested by Fletcher (1898, p. 679). Later Fry (1915, p. 70) rescued *australiacus* from the oblivion in which it had lain for over a century, and correctly identified it with *flavoguttatus*. Our fine male, taken in January, 1912, by the donor, measures 83 mm.

Limnodynastes peronii peronii (Duméril & Bibron)

Cystignathus peronii Duméril & Bibron, 1841, Erpét. Gén., **8**, p. 409: "?Nouvelle-Hollande."

1 (M. C. Z. 879) New South Wales (Göttingen Mus.) N. D.
2 (M. C. Z. 1939) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 2247) Brisbane, Q. (Australian Mus.) 1914.
2 (M. C. Z. 18527–8) Blackheath, N. S. W. (P. J. Darlington) 1932.

All six frogs are characterized by the metatarsal tubercle of the adpressed hind limb reaching well beyond the end of the snout. This is not the case with any of the examples of the northern subspecies in our collection. Number 18538 has lost its left foot at the tibio-tarsal joint, the latter terminates in two fleshy pseudodigits, the larger slightly over 3 mm. in length. The four older frogs are somewhat macerated. The largest specimen (No. 18537) measures 53 mm.

Compared with two examples in the Philadelphia Academy of Natural Sciences (Nos. 10062-3) believed to be cotypes and received from Duméril.

Limnodynastes peronii lineatus De Vis

Limnodynastes lineatus De Vis, 1884, Proc. Linn. Soc. N. S. W., **9**, p. 65: Mackay, Queensland.

2 (M. C. Z. 9587–8) Ebor, N. S. W. (W. F. H. Rosenberg) 1924.
1 (M. C. Z. 18168) Barrington Tops, N. S. W. (P. J. D.) 1932.
1 (M. C. Z. 18169) Millaa Millaa, Q. (P. J. Darlington) 1932.

The Ebor frogs were purchased from Rosenberg as *tasmaniensis* which they certainly are not. In Boulenger's key (1882, p. 258) they run down to *platycephalus* from Adelaide but differ from that species in possessing a single metatarsal tubercle and in their very different coloration, which agrees with that of *peronii*.

The whole series differ from typical *peronii*, however, in their shorter hind limbs of which the tarso-metatarsal articulation, when adpressed, reaches the nostril (Nos. 9587-8) or end of snout (Nos. 18168-9) which conforms to De Vis' statement that "the ankle reaches the front edge of the orbit." Excepting that the snout may be said to *equal* the diameter of the orbit, they agree perfectly with De Vis' description even to details of markings. The placing of *lineatus* in the synonymy of *peronii*, as has been done by several authors, would appear to be unjustifiable unless it can be demonstrated that this striking difference in leg length has no geographical significance.

The series shows the inner metatarsal tubercle to be short and blunt, no outer tubercle; the tibio-tarsal articulation of the adpressed hind limb reaches to the shoulder or almost to the eye (No. 18168); the vomers extend laterally well beyond the choanae; first finger shorter than the second. The largest specimen (No. 18169) measures 60 mm.

Limnodynastes salmini Steindachner

Limnodynastes salmini Steindachner, 1867, Reise Oesterr. Freg. Novara, Amphib., p. 27, pl. iv, figs. 12–15: Australia.
Limnodynastes olivaceus Fry (not of De Vis), 1915, Proc. Roy. Soc. Queensl., **27**, p. 65; (redescription).

1 (M. C. Z. 3610) Mapoon, Q. (Australian Mus.) 1914.
♂ (M. C. Z. 3623) Burnett River, Q. (Australian Mus.) 1914.
♀ (M. C. Z. 3624) Richmond, N. S. W. (Australian Mus.) 1914.

The Mapoon frog was received from the Australian Museum as *olivaceus* De Vis, and is presumably one of the four specimens on which Fry based his redescription of *olivaceus*. In this Fry was in error for the type of *olivaceus*, as described by De Vis, had two metatarsal tubercles, the Mapoon frog only one; it differs in several other ways from the description of *olivaceus*. As stated below, I consider *olivaceus* to be a synonym of *tasmaniensis* though it may possibly constitute a northern race of that frog. On the other hand the Mapoon frog only differs from the Burnett River and Richmond River specimens in that its first finger equals the second, instead of being slightly longer.

The three frogs listed above agree in having the vomers extending laterally well beyond the choanae; the tibio-tarsal articulation of the adpressed hind limb reaches to the shoulder or the eye; the metatarsal tubercle to the eye or just beyond; first finger equal to, or longer than, the second; length of snout equal to, or slightly shorter than, the diameter of the orbit; vertebral stripe absent, or faintly suggested (No. 3610) as in the figure of the type. The largest specimen (No. 3624) measures 45 mm.

Limnodynastes tasmaniensis Günther

Limnodynastes tasmaniensis Günther, 1858, Cat. Batr. Sal. Brit. Mus., p. 33, pl. ii, fig. B: Tasmania.
Limnodynastes affinis Günther, 1863, Ann. Mag. Nat. Hist. (3), **2**, p. 27: Clarence River, New South Wales.
Limnodynastes peronii var. *rugulosus* Keferstein, 1867, Nachr. Ges. Göttingen, p. 344: Sydney, New South Wales.
Limnodynastes olivaceus De Vis, 1884, Proc. Linn. Soc. N. S. W., **9**, p. 66: Mackay, Queensland.

9 (M. C. Z. 399) Australia (No further data) N. D.
1 (M. C. Z. 1901) Victoria (H. A. Ward) 1884.
6 (M. C. Z. 3611–6) Eidsvold, Q. (Australian Mus.) 1914.
1 (M. C. Z. 19333) Launceston, T. (E. O. G. Scott) 1933.
1 (M. C. Z. 19580) Kangaroo Island, S. A. (E. R. Waite) 1924.

Six frogs of this genus have been described which are said to have two metatarsal tubercles. Two of these have been referred to the synonymy of *tasmaniensis* by Boulenger, a third (*olivaceus*) is added for reasons stated in detail below. The remaining two are *L. platycephalus* Günther, 1867, from Adelaide, S.A., and *L. fletcheri* Boulenger, 1888, of Guntawang, near Mudgee, N.S.W., of the latter I have no material but they appear to be well differentiated. A seventh species, *L. marmoratus* Lamb, was stated by its author to have only *one* metatarsal tubercle but has been put into the synonymy of *fletcheri* by Fry (1912, p. 98) as a probability; his action appears well justified.

Fry has referred the Eidsvold specimens to *tasmaniensis* but I find that they only differ from the description of *olivaceus* in their vomerine teeth. In *olivaceus* these were said to extend "a little beyond the choanae." In our Queensland series they vary from those markedly within the choanae to others in which the vomerine teeth reach well to the outer borders of the choanae; as they show so much variation I am prepared to assume that in the holotype of *olivaceus* they may have been even more extended.

The series agrees in the tarso-metatarsal articulation of the adpressed hind limb reaching to the eye or tip of the snout, the tibiotarsal articulation reaching to the shoulder or eye; first finger shorter, or equal to, the second; snout (from nostril) is equal to, or a trifle shorter than, the orbital diameter (in *tasmaniensis* and *olivaceus* it is said to be "longer" and "rather longer"). The largest specimen (No. 19580) measures 48 mm.

Limnodynastes platycephalus Günther

Limnodynastes platycephalus Günther, 1867, Ann. Mag. Nat. Hist. (3), **20**, p. 54: Adelaide, South Australia.

1 (M. C. Z. 19581) Kangaroo Island, S. A. (E. R. Waite) 1924.
1 (M. C. Z. 19600) Wilpena, S. A. (H. M. Hale) 1921.

Number 19581 was originally received from the South Australian Museum as *L. tasmaniensis* together with an example of that species from the same locality and taken by the same collector.

The species is very close to *tasmaniensis* as stated by Boulenger (1882, p. 261) but differs from it by the broader head and very different color pattern. The hind limb probably averages longer in *platycephalus* but I fail to find any difference in length of snout between the two species.

The tarso-metatarsal articulation of the adpressed hind limb reaches to the nostril (No. 19600 which is young) or beyond the tip of the snout (No. 19581, adult); the first finger is shorter than the second. The larger frog (No. 19581) measures 39 mm.

Limnodynastes dorsalis dorsalis (Gray)

Cystignathus dorsalis Gray, 1841, in Grey's Journ. Exped. Discov. West. Australia, p. 446: Western Australia.

2 (M. C. Z. 396, 398) Australia (H. A. Ward) N. D.
2 (M. C. Z. 13017–8) Balcatta Beach, W. A. (W. S. Brooks) 1926.
1 (M. C. Z. 18153) Nornalup, W. A. (G. E. Nicholls) 1925.
1 (M. C. Z. 18154) Point Peron, W. A. (Harvard Exped.) 1931.
1 (M. C. Z. 19258) Eaglehawk Neck, T. (F. N. Blanchard) 1928.
1 (M. C. Z. 19330) Tasmania (T. S. M. English) 1903.
1 (M. C. Z. 19371) Stanley, T. (E. O. G. Scott) 1933.

These frogs agree well with Fry's (1913, p. 23) key to the typical form excepting that No. 18153 presents a granular appearance dorsally, possibly due to the method of preservation. The largest specimen (No. 18154) measures 64 mm.

Limnodynastes dorsalis dumerilii Peters

Limnodynastes (*Platyplectron*) *dumerilii* Peters, 1863, Monatsb. Akad. Wiss. Berlin, p. 235: Adelaide, South Australia.

1 (M. C. Z. 2248) Brisbane, Q. (Australian Mus.) 1914.
1 (M. C. Z. 2249) Cootamundra, N. S. W. (Australian Mus.) 1914.

Brisbane is near the northern limits of this race as defined by Fry (1915, p. 68). The larger specimen (No. 2249) measures 64 mm.

Limnodynastes dorsalis terraereginae Fry

Limnodynastes dorsalis var. *terrae-reginae* Fry, 1915, Proc. Roy. Soc. Queensl., **27**, p. 67, fig. 2a: Somerset, Cape York, Queensland.
Limnodynastes dorsalis Garman, 1901, Bull. Mus. Comp. Zoöl., **39**, p. 14.

1 (M. C. Z. 2315) Cooktown, Q. (E. A. C. Olive) 1896.
1 (M. C. Z. 2560) Queensland, (T. Barbour don.) 1909.
8 (M. C. Z. 3702, 18155–9) Eidsvold, Q. (T. L. Bancroft) V. D.

The Cooktown specimen listed by Garman (1901, p. 14) and Fry (1913, p. 28) differs from all the others in its handsome coloring—brown streaks and vermiculations superimposed on a cream-colored ground. The Eidsvold, Burnett River frogs are, in a sense, topotypes of Fry's paratypes from that locality. The largest specimen (No. 3702) measures 79 mm.

Limnodynastes ornatus (Gray)

Discoglossus ornatus Gray, 1842, Zoöl. Miscellany, **2**, p. 56: Port Essington, Northern Territory.

♂ ♀ (M. C. Z. 3601–2) Somerset, Q. (Australian Mus.) 1914.
8 (M. C. Z. 18160–7) Coen, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18485) Mundubbera, Q. (W. E. Schevill) 1932.
1 (M. C. Z. 18486) Rutherford, Sellheim R., Q. (L. MacFarlane) 1932.
35 (M. C. Z. 18530–46) Hermannsburg, N. T. (W. E. Schevill) 1932.

The tibio-tarsal articulation of the adpressed hind limb reaches the axilla or the eye. The largest specimen (No. 18530) measures 48 mm.

Lechriodus fletcheri (Boulenger)

Phanerotis fletcheri Boulenger, 1890, Proc. Linn. Soc. N. S. W. (2), **5**, p. 593: Dunoon, Richmond River, New South Wales.
Ranaster fletcheri Nieden, 1923, Das Tierreich, **46**, Anura, **1**, p. 535.
Lechriodus fletcheri Noble, 1931, Biol. Amphib., p. 497.

1 (M. C. Z. 18170) Salisbury, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18171) Cascade, N. S. W. (P. J. Darlington) 1932.

The first locality is 1,000 feet in altitude, the second, near Dorrigo, 3,000 feet.

Lechriodus was proposed by Boulenger to replace Batrachopsis Boulenger, preoccupied by Batrachopsis Fitzinger. The other species of the genus inhabits western New Guinea. Noble has transferred Lechriodus from the Pelobatidae to Criniinae, which he regards as a subfamily of Bufonidae. Andersson has recorded *fletcheri* from New Guinea.

Except that the first finger may be slightly shorter than the second

(instead of equal), these frogs agree so closely with the original specific (not generic) description of *fletcheri* that further comment is unnecessary. The dilated second finger of the female resembles that of a Limnodynastes. The larger female (No. 18171) measures 50 mm.; the type was only 33 mm.

Adelotus brevis (Günther)

Cryptotis brevis Günther, 1863, Ann. Mag. Nat. Hist. (3), **11**, p. 27, pl. iv, fig. B: Clarence River, New South Wales.

1 (M. C. Z. 1933) Clarence River, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 3589) Nambucca River, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 3590) Lismore, N. S. W. (Australian Mus.) 1914.

Adelotus was proposed by Ogilby (1907, p. 32) to replace Cryptotis Günther, 1863, preoccupied by Cryptotis Dana, 1852. I might point out that a still earlier use of the name occurs when it was proposed by Pomel in 1848. This distinctive species is not likely to be confused with any other. The largest specimen (No. 3590) measures 40 mm.

Crinia georgiana Tschudi

Crinia georgiana Tschudi, 1838, Classif. Batr., p. 78.
Cystignathus georgianus Duméril & Bibron, 1841, Erpét. Gén., **8**, p. 416: King George's Sound, Nuyts coast, (South) Western Australia.

3 (M. C. Z. 18393–5) Lesmurdie, W. A. (G. E. Nicholls) 1931.
2 (M. C. Z. 18396–7) Swan View, W. A. (Harvard Exped.) 1931.
8 (M. C. Z. 18398–405) Rottnest Id., W. A. (Harvard Exped.) 1931.
2 (M. C. Z. 18406–7) Margaret River, W. A. (Harvard Exped.) 1931.
8 (M. C. Z. 18408–11) Pemberton, W. A. (Harvard Exped.) 1931.

These frogs agree in possessing two metatarsal tubercles (Duméril & Bibron state that there is a single metatarsal tubercle, but their description fits these specimens rather than *leai* Fletcher or its eastern allies; the type of *georgianus* should be reëxamined, however). It will be noted that both *leai* and *georgiana* occur at Margaret River and at Pemberton. The tibio-tarsal articulation of the adpressed hind limb reaches the temple; tympanum hidden; vomerine teeth present; back with a few scattered warts and raised, undulating, glandular folds, the principal pair, lyre-shaped, proceeding from the eyelids backwards to lie along either side of the vertebral line; below, strongly granular. Breeding males with strongly swollen forearms and black throats, rest

of the series white below, usually flecked with dark spots, sometimes immaculate. The largest male measures 32 mm., and female, 35 mm. The Rottnest series are mostly young with tails, those that have lost them measuring 11.5 mm.

Crinia glauerti Loveridge

Crinia glauerti Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 57: Mundaring Weir, near Perth, Western Australia.

5 (M. C. Z. 18420–2) Mundaring Weir, W. A. (P. J. Darlington) 1931.

These are the types of what may be regarded as a miniature form of *georgiana*. A breeding ♂ of *glauerti*, with swollen arms and black throat, measures 15.5 mm. as against 32 mm. in *georgiana*; similarly a gravid ♀ measures 20.5 mm. as against 35 mm.

Crinia signifera signifera (Girard)

Ranidella signifera Girard, 1853, Proc. Acad. Nat. Sci. Philad., **6**, pp. 421–422: Australia.

Crinia stictiventris Cope, 1867, Journ. Acad. Nat. Sci. Philad. (2), **6**, p. 202: Australia.

1 (M. C. Z. 877) New South Wales (Göttingen Mus.) N. D.
1 (M. C. Z. 1938) Sydney, N. S. W. (Göttingen Mus.) 1885.
2 (M. C. Z. 3521–2) New South Wales (T. Steel) 1914.
2 (M. C. Z. 18412–3) Megalong Valley, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18506) Blackheath, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18507) Canberra, F. C. T. (P. J. Darlington) 1931.
1 (M. C. Z. 19225) Near National Park, T. (F. N. Blanchard) 1928.
1 (M. C. Z. 19334) Launceston, T. (E. O. G. Scott) 1933.
7 (M. C. Z. 19593–9) Wilpena, S. A. (H. M. Hale) 1921.

Wilpena is in the North Flinders Range.

Through the courtesy of the Director of the Academy of Natural Science, Philadelphia, I have had the opportunity of examining two frogs (A.N.S.P. 10059-60) which may well be Girard's types (he does not say if he had more than one) of *signifera*. They do not correspond to Cope's descriptions of the ♂ and ♀ cotypes of *stictiventris*; the latter should be in the collection of the Museum of Comparative Zoölogy but are not, neither has search for them in the Philadelphia Academy brought them to light.

Our series listed above agree in possessing two metatarsal tubercles; the tibio-tarsal articulation of the adpressed hind limb reaches the shoulder or the temple; tympanum hidden; vomerine teeth absent; back with prominent, lyre-shaped, dorsal plicae and small warts, except when macerated; below, granular or areolate; toes with a narrow fringe which may be masked by preservation. Above, with an arrow-shaped interorbital mark, dorsal markings and lateral bands; below, white, so heavily overlaid with brown or black as to be concealed except for a sprinkling of fine spots on the throat and sometimes a large patch in the centre of the belly. The largest specimen, a female (No. 877) measures 24 mm.

The coloration of the ventral surfaces of Numbers 877 and 1938 is identical with that of Numbers 3523, 17999 and 18415 which are referred to *C. a. haswelli* on account of their different dorsal coloring and smooth backs.

Crinia signifera ignita Cope

Crinia ignita Cope, 1866, Journ. Acad. Nat. Sci. Philad. (2), **6**, p. 95: Western Australia.

Crinia stolata Cope, 1867, Journ. Acad. Nat. Sci. Philad. (2), **6**, p. 201: Western Australia.

1 (M. C. Z. 1937) Australia (Göttingen Mus.) 1885.
15 (M. C. Z. 12993–7) Denmark, W. A. (W. S. Brooks) 1927.
46 (M. C. Z. 13000–5) Augusta, W. A. (W. S. Brooks) 1927.
10 (M. C. Z. 13006–10) Mouth of Denmark R., W. A. (W. S. Brooks) 1927.
56 (M. C. Z. 13011–5) Manjimup, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 13016) Balcatta Beach, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 18508) Margaret River, W. A. (P. J. Darlington) 1931.

Boulenger (1882, p. 264) referred *ignita* with a query, to the synonymy of *C. georgiana* and treated *stolata* as a "var." of the same species. Recently, through the kindness of the Director of the Academy of Natural Science, Philadelphia, and Dr. E. R. Dunn, I have had the opportunity of examining the types of both *ignita* (A.N.S.P. 10058) and *stolata* (A.N.S.P. 10061) and find them to be but color variants of one and the same species which I consider the western representative of *signifera* (Girard). Unfortunately *ignita* must take precedence over the better known *stolata*. Both types were received from the same collector—Daniels.

Number 1937 was received as *georgiana* Tschudi; one would have expected this Göttingen specimen to have come from the vicinity of Sydney like so much of their material. It has, however, the white ventral surface and lacks the fringe on the toes, which shows that it is a western frog.

This race is very variable in coloration. A common type has been admirably figured by Fry (1914, pl. xxviii, fig. 1) under the name of *Crinia georgiana* var. *stolata*. Though the undersurface is often flecked with brown, it never (at least so far as our extensive series shows) exhibits the customary heavy marbling of the typical form. Should occasional specimens with heavy marbling occur, I scarcely think it would invalidate this treatment of *ignita* as a western race. A young frog in the Denmark series has numerous supernumerary metatarsal and tarsal tubercles, in all the rest only two metatarsal tubercles are present. The largest specimen (No. 13015) measures 33 mm.; many of the series are young.

In his Contribution to the Fauna of Rottnest Island, Mr. L. Glauert (1929, p. 44) records *C. signifera* whereas our material from the island agrees with *georgiana*. I wrote to Mr. Glauert on this point and he replied (19. v. 1933) "So far as the Rottnest forms are concerned I see no reason for removing them from *signifera* and including them in *georgiana*. None of the specimens had red on the thighs whilst the markings did not seem to agree with those that I associated with *georgiana*." From this absence of red I feel certain that Mr. Glauert's specimens were not *C. signifera ignita* but what I understand as *georgiana*. Of the four species of Amphibia recorded from the island by Glauert, the Harvard Expedition failed to get *Limnodynastes dorsalis dorsalis*; his *Helioporus albopunctatus* must now be referred to the recently described *H. insularis*.

Crinia affinis affinis (Günther)

Pterophrynus affinis Günther, 1864, Proc. Zoöl. Soc. London, p. 47, pl. vii, fig. 2: Western Australia.

5 (M. C. Z. 18426–30) Near Denmark, W. A. (W. S. Brooks) 1927.
11 (M. C. Z. 18431–35) Manjimup, W. A. (W. S. Brooks) 1927.
20 (M. C. Z. 18436–50) Augusta, W. A. (W. S. Brooks) 1927.

I confess to being considerably puzzled by the status of this frog which Boulenger treated as a race of *georgiana*. It will be noted that what I call *affinis* occurs in the same localities and at the same time

with *C. signifera ignita* Cope. Our *affinis* consistently differ from *ignita*, however, in being perfectly smooth above and without a trace of the characteristic lyre-shaped, dorsal plicae of *ignita*. Moreover in coloring the *affinis* are almost uniform gray or pale brown above though occasionally there may be a trace of a vertebral line; there is none of the fantastic pattern which is present on the back of *ignita*.

Sensing the possibility that these differences were of a sexual character, adults of both *ignita* and *affinis*, as well as their counterparts *signifera* and *haswelli*, were examined and representatives of both sexes found in each of the first three groups. It does not seem rational to treat *affinis* and *haswelli* as merely color mutants of *ignita* and *signifera* in view of the absence of glandular folds and warts which constitute a second character. Their distribution precludes their being treated as geographical races of *ignita*, or rather *signifera*. It seems that they must be treated as a species and subspecies apart.

These frogs agree in possessing two metatarsal tubercles; the tibiotarsal articulation of the adpressed hind limb reaches to the temple or eye; tympanum hidden; vomerine teeth present but indistinct; back smooth; throat and belly strongly granular. Above, back usually uniformly gray or pale brown, only very rarely with a few flecks of brown, occasionally a hair-like, light, vertebral line; a black lateral line (often interrupted above the arm); below, throat and belly white, sometimes (one third of the specimens) flecked with brown; rose on thighs. The largest specimen (No. 18426) measures 27 mm.

Crinia affinis haswelli Fletcher

Crinia haswelli Fletcher, 1894, Proc. Linn. Soc. N. S. W. (2), **8**, p. 522: Near head of Jervis Bay, New South Wales.

1 (M. C. Z. 3523) New South Wales (T. Steel) 1914.
1 (M. C. Z. 17999) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 18415) Salisbury, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18509) Hartley Vale, N. S. W. (P. J. Darlington) 1932.
9 (M. C. Z. 19584–92) Third Creek, Magill, S. A. (Tepper) 1885.

These differ from Fletcher's description only in the absence of vomerine teeth, but it has been established that their presence or absence in the genus Crinia is not of specific importance. Fletcher (1894, p. 523) has stated that they are both present and absent in his type series of *froggatti*.

In this connection I would direct the attention of Australian herpetologists to the general absence of vomerine teeth in southeast Australian Crinia, their presence in the southwestern forms, and to Mr. H. W. Parker's (1930, Proc. Zoöl. Soc. London, pp. 1–2) interesting comments on the absence of vomerine teeth in Ethiopian amphibia and its possible connection with the alkaline, calcium-deficient waters of that region.

It should be noted that No. 3523 was associated with *C. s. signifera* Nos. 3521–2, and that No. 17999 was formerly part of *signifera* No. 1938, two frogs being registered under that number. These *haswelli* differ from *signifera* by their smooth backs, absence of dorsal plicae and warts, and by their color which resembles that of *affinis*. They differ from the western *affinis* in possessing fringed toes and in the heavy mottling of their underside, the coloration of the latter being indistinguishable from that of *signifera*. It will be seen therefore that *haswelli* differs from *affinis* in precisely the same way that *signifera* differs from *ignita*.

These frogs agree in possessing two metatarsal tubercles; the tibiotarsal articulation of the adpressed hind limb reaches to the shoulder or temple; tympanum hidden; vomerine teeth absent; back smooth; throat and belly granular or areolate. Above, back gray; a black or brown lateral line; below, white, so heavily overlaid with brown or black as to be concealed except for a sprinkling of fine spots on the throat and a large patch in the centre of the belly. The largest of these three females (No. 18415) measures 63 mm.

Crinia tasmaniensis (Günther)

Pterophrynus tasmaniensis Günther, 1864, Proc. Zoöl. Soc. London, p. 48, pl. vii, fig. 3: Tasmania.

10 (M. C. Z. 19240–9) Cradle Valley, T. (F. N. Blanchard) 1928.

These are part of the series referred to by Blanchard (1929, p. 324) who rediscovered the species after a lapse of sixty-four years. The females differ in ventral coloration from Günther's colored figure in having the lower surfaces white with a few large black vermiculations. Parker (in Blanchard, 1929, p. 328) has commented on these differences. The males approximate the plate in that the white of the ventral surface is almost obscured by the black. Larger male measures 17 mm.; largest female, 30 mm.

Crinia laevis laevis (Günther)

Pterophrynus laevis Günther, 1864, Proc. Zoöl. Soc. London, p. 48, pl. vii, fig. 4: Tasmania.

6 (M. C. Z. 19226–31) Wilmot, T. (F. N. Blanchard) 1928.
1 (M. C. Z. 19331) Tasmania, (T. M. S. English) 1901–3.
1 (M. C. Z. 19335) Dunorlan, T. (E. O. G. Scott) 1933.

These topotypes are smooth above and below; usually without, though rarely with, faintly developed metatarsal tubercles; the tibiotarsal articulation of the adpressed hind limb reaches to, or just beyond, or just short of, the axilla; vomerine teeth absent. Light spots on a black ground in groin. Largest ♀ measures 29 mm.

Crinia laevis froggatti Fletcher

Crinia froggatti Fletcher, 1891, Proc. Linn. Soc. N. S. W., **6**, p. 275: Buninyong and Gong Gong, near Ballarat, Victoria.

8 (M. C. Z. 19232–9) Healesville, V. (F. N. Blanchard) 1928.

Though Healesville is much nearer to Warragul (which is type locality of *victorina* Boulenger, 1888) than to Ballarat, these frogs agree rather with *froggatti* than with *victorina*. Boulenger (1888, p. 142) noted that the vomerine teeth were very small in his species and this caused Fletcher (1894, p. 523) to reëxamine his type series and find that teeth were both present and absent in the types. He concludes that *froggatti* is only a "variety" of *laevis* with which I agree in a subspecific sense. Blanchard (1929, p. 328) discusses the differences. Largest ♀ measures 25 mm.

Crinia darlingtoni Loveridge

Crinia darlingtoni Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 57: National Park, MacPherson Range, Queensland.

3 (M. C. Z. 18390–2) National Park, Q. (P. J. Darlington) 1932.

These are the types of a Crinia which is distinguished from all other members of the genus by the rudimentary nature of the first finger and the very minute first toe. In coloration some specimens agree closely with *C. acutirostris* Andersson.

Crinia acutirostris Andersson

Crinia acutirostris Andersson, 1916, Svenska. Vetensk.-Akad. Handl., Stockholm, **52**, No. 9, p. 8, fig. 2, pl. i: Malanda, Queensland.

1 (M. C. Z. 18416) Mt. Spurgeon, Q. (P. J. Darlington) 1932.

This interesting discovery of Dr. Mjöberg's extended the range of the genus on the continent considerably to the north, Dr. Darlington's capture still more so, for Mount Spurgeon is seventy miles north of the type locality.

The broad, ribbon-like, interorbital vertebral band resembles that of *leai* Fletcher, a species to which *acutirostris* would appear to be related by its single metatarsal tubercle, though differing in a much broader snout; the tibio-tarsal articulation of the adpressed hind limb reaches to the posterior corner of the eye; tympanum *just distinguishable; vomerine teeth absent;* back and belly smooth. Length 21 mm.

Crinia leai Fletcher

Crinia leai Fletcher, 1897, Proc. Linn. Soc. N. S. W., **22**, p. 677: Bridgetown and Jarrahdale, Western Australia.

Crinia michaelseni Werner, 1914, in Michaelsen & Hartmeyer's Fauna Südwest-Australien, **4**, p. 416: Donnybrook, Western Australia.

15 (M. C. Z. 12998–9) Manjimup, W. A. (W. S. Brooks) 1927.
4 (M. C. Z. 18451–4) Denmark, W. A. (W. S. Brooks) 1927.
36 (M. C. Z. 18455–64) Near Denmark River, W. A. (W. S. Brooks) 1927.
51 (M. C. Z. 18465–75) Augusta, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 18476) Margaret River, W. A. (W. E. Schevill) 1931.
3 (M. C. Z. 18477–9) Pemberton, W. A. (W. E. Schevill) 1931.

This perfectly distinct frog appears to be the western representative of *varius* Peters, 1863, of Adelaide, South Australia, a species which Boulenger discarded as he considered it a composite. I have not seen any specimens.

Crinia rosea Harrison

Crinia rosea Harrison, 1928, Rec. Austral. Mus. Sydney, **15**, p. 278: Pemberton, Karri Country, 218 miles south of Perth, Western Australia.

3 (M. C. Z. 18417–9) Pemberton, W. A. (P. J. Darlington) 1931.

Closely related to *leai* Fletcher but distinguished by the absence of any metatarsal tubercles and the shorter hind limb, for the tibio-tarsal

articulation of the adpressed limb reaches to the axilla (in our Pemberton *georgiana* and *leai*, far beyond): back and belly smooth. No lateral band; thighs not vermilion; rose on throat still showing a year after preservation; while lower surface dusky owing to fine freckling only observable with the aid of a lens. The largest specimen (No. 18417) measures 25 mm.

In life, "Back variegated dark brown; throat and belly vermilion; a few small, scattered, vermilion spots on underside of legs." (W. E. S.)

Uperoleia marmorata rugosa Andersson

Pseudophryne rugosa Andersson, 1916, Svenska Vetensk.-Akad. Handl., Stockholm, **52**, No. 9, p. 13, pl. i, fig. 4: Colosseum, southern Queensland.
Pseudophryne fimbrianus Parker, 1926, Ann. Mag. Nat. Hist. (9), **17**, p. 669, fig. 3: St. George district, southern Queensland.

1 (M. C. Z. 395) Australia (No further history) N. D.
2 (M. C. Z. 878, 1931) New South Wales (Göttingen Mus.) 1885.
2 (M. C. Z. 2559) Queensland (? H. A. Ward) 1909.

Uperoleia only differs from Pseudophryne according to Boulenger, in its erect pupil. This character can be seen in all our specimens except No. 395 which is too dried. The pupil tends to be diamond shaped but compressed laterally.

Harrison (1927, p. 284) has suggested the possibility of *Pseudophryne mjobergii* Andersson, 1913, from Noonkambah, Kimberley Division, Western Australia, being synonymous with *marmorata*. However, Andersson stresses the fact that both his male and female types possess a tarsal tubercle as well as two metatarsal tubercles. As neither *marmorata* nor any Pseudophryne possess this character I prefer to regard *mjöbergii* as distinct though it certainly appears to be very similar to *marmorata*.

All agree in having a light patch on the hind arm near the shoulder, another in the groin and a third on the hinder side of the tibia, in which respect they show their affinity to *Pseudophryne albifrons* Duméril & Bibron. The longest toe of the adpressed hind limb reaches just beyond the tip of the snout (Queensland) or far beyond (New South Wales). The largest specimen (No. 2559) measures 26 mm.

Pseudophryne australis (Gray)

Bombinator australis Gray, 1835, Proc. Zoöl. Soc. London, **3**, p. 57: Swan River, Western Australia.

Pseudophryne australis Stirling & Zietz, 1893, Trans. Roy. Soc. S. Austral., Adelaide, **16**, p. 176: (Forty miles northwest of the Fraser Range, Western Australia).

41 (M. C. Z. 18301–25) Burara, s. of Kalgoorlie, W. A. (G. E. N.) 1931.

For discussion on the status of this species see under *P. albifrons* (Duméril & Bibron) following.

The Burara specimens, received from Prof. G. E. Nicholls, have the coloring of *P. albifrons* of Sydney though much fainter; on the belly white (yellow ?) predominates instead of black as is the case with *albifrons*. In this they resemble *P. guentheri* but differ from that species in their much smaller tubercles. Fry (in Harrison, 1927, p. 282, fig. 1) has figured them under the name of *guentheri*. Tip of the fourth toe of the adpressed hind limb reaches to the eye or the nostril. The largest specimen, a female, measures 33 mm.

Pseudophryne albifrons (Duméril & Bibron)

Phryniscus albifrons Duméril & Bibron, 1854, Erpét. Gén., **9**, p. 413, pl. c, fig. 3: No type locality mentioned.

1 (M. C. Z. 875) New South Wales (Göttingen Mus.) N. D.
2 (M. C. Z. 1932) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 2250) Gosford, N. S. W. (Australian Mus.) 1914.

All the above were received as *australis*, a western species which Boulenger (1882, p. 277) confused with *albifrons*. As a result we meet with the continued assertion that "*australis*" only occurs within a seventy mile radius of Sydney and the presumption that Gray was in error when he stated that his type came from Swan River! Nieden (1923, p. 148) gets over the difficulty in a delightful way by omitting all mention of Swan River and giving the range as New South Wales. No such supposition is necessary, for Australian herpetologists have been confusing true (western) *australis* with *guentheri*, though the latter has much larger metatarsal tubercles. Fry (in Harrison, 1927, p. 282) figures three perfectly distinct species as variations of *guentheri*. Thus

Fig. 1 represents *P. australis* (Gray)
" 2 " *P. brooksi* Loveridge
" 3 " *P. guentheri* Boulenger

so far as I can judge without actual examination of the material.

Pseudophryne blanchardi Loveridge

Pseudophryne blanchardi Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 91: Millgrove, Victoria.

♂ ♀ (M. C. Z. 19259–60) Millgrove, V. (F. N. Blanchard) 1928.

These are type and paratype of a species characterized by the absence of a white or light frontal area, also limb length. An extensive series of paratypes is in Dr. Blanchard's collection.

In addition I have examined a series of ten toads from Healesville, Victoria which are not quite typical. They differ in not having the whole of the throat white and in possessing a pigmented circumanal area on the hinder aspect of the thighs.

Pseudophryne bibronii Steindachner

Pseudophryne bibronii Steindachner, 1867, Reise Oesterr. Freg. Novara. Amphib., p. 34, pl. v, figs. 1 and 2: Australia and Tasmania.

3 (M. C. Z. 881, 1930) Sydney, N. S. W. (Göttingen Mus.) 1885.
4 (M. C. Z. 19336–8) St. Patrick's River, T. (E. O. G. Scott) 1933.
2 (M. C. Z. 19581–2) Torrens River, S. A. (A. Zeitz) 1905.

Uniformly brown or olive above except for a light patch on the hind arm near the shoulder; below, handsomely marbled; tip of the fourth toe of the adpressed hind limb reaches to the eye or just beyond. The largest specimen (No. 19581) measures 30 mm.

All three frogs are infested with larvae of the fly Batrachomyia.

Pseudophryne coriacea Keferstein

Pseudophryne coriacea Keferstein, 1868, Arch. Naturg., p. 272, pl. vi, fig. 15: Clarence River, New South Wales.

1 (M. C. Z. 1941) Clarence River, N. S. W. (Göttingen Mus.) 1885.
3 (M. C. Z. 18220–2) Salisbury, N. S. W. (P. J. Darlington) 1932.

In our cotype, as well as in two adults from Salisbury, the pale brown upper surface is sharply defined from the black of the sides and belly; the latter is marbled with lighter in a very characteristic manner; a young toad shows no such differentiation of dorsal and lateral pigmentation, being uniformly plumbeus both above and on the sides but with a light, inverted, T-shaped marking above the anus as in

dendyi. The tip of the fourth toe of the adpressed hind limb reaches to the nostril or beyond the end of the snout. The largest specimen (No. 18220) measures 29 mm.

Pseudophryne dendyi Lucas

Pseudophryne dendyi Lucas, 1892, Proc. Roy. Soc. Victoria (2), **4**, p. 62: North Gippsland, Victoria.

2 (M. C. Z. 18223–4) Daner's Gap, N. S. W. (W. E. Schevill) 1932.
1 (M. C. Z. 18225) Digger's Creek, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 18414) Megalong Valley, N. S. W. (P. J. Darlington) 1932.
6 (M. C. Z. 18510–5) Hartley Vale, N. S. W. (P. J. Darlington) 1932.

The first two localities are on Mt. Kosciusko, the last two in the Blue Mountains.

According to Harrison (1927, p. 268) the unique 15 mm. holotype of *dendyi* is lost; that the specimens listed above are conspecific with it there can be no manner of doubt, but whether *dendyi* is distinct from *bibronii* I cannot be so sure as our material of the latter is very old and inadequate. Undoubtedly *dendyi* is nearly related to *coriacea* also. Mt. Kosciusko is not far from the type locality of *dendyi*.

Our frogs agree in having a light patch on the hind arm near the shoulder; most of them display the inverted, T-shaped marking above the anus (as in *australis* and *coriacea*) but in others, including the adult, it is absent; tip of the fourth toe of the adpressed hind limb reaches to the shoulder or more often to the eye. Young specimens so closely resemble the young *coriacea* from Salisbury that they can only be distinguished by the shorter hind limb. The largest specimen (No. 18225) measures 32 mm.

Of the Digger's Creek specimen Darlington writes: "When disturbed, this toad so hunched itself that the yellow markings at the shoulder and rear were prominently displayed. It threw its elbows outwards." (P. J. D.)

Pseudophryne semimarmorata Lucas

Pseudophryne semimarmorata Lucas, 1892, Proc. Roy. Soc. Victoria (2), **4**, p. 63: North Gippsland, Victoria.

87 (M. C. Z. 18226–50) s. of Etheridge Range, N. S. W. (W. E. S.) 1932.
36 (M. C. Z. 18251–75) Daner's Gap, N. S. W. (W. E. Schevill) 1932.

Both these localities are on Mt. Kosciusko, the altitudes being 6,500 and 5,400 feet respectively, and are near the type locality of *semimarmorata*.

Uniformly black above without light spot on hind arm, anus, or hinder side of tibia, very rarely an ill-defined light spot on the groin; the tarso-metatarsal joint of the adpressed hind limb reaches the eye, the tip of the fourth toe well beyond the end of the snout. The largest specimens from each locality measure 30 and 28 mm. respectively but each series contains many juveniles measuring 12 mm. or thereabouts.

"These toads were taken where the snow water had spread out into shallow, still pools and then been appreciably warmed by the sun; usually in places with dark bottom, not on sand. Occasionally the toads were found under stones in the water. A pair of toads were taken in embrace. Some of them had been laying eggs and many tadpoles of various sizes were seen in the shallow pools. There were, however, two sizes of eggs, one of which may have belonged to the frogs (*Hyla ewingii alpina*). A number of semidecayed frogs were lying about, even in the pools in which only toads were seen; these were larger than any taken in the pools, though not so large as (No. 18055=46 mm.)." (W. E. S.).

Pseudophryne brooksi Loveridge

Pseudophryne brooksi Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 59: Manjimup, near Pemberton, West Australia.

10 (M. C. Z. 13025–31) Manjimup, W. A. (W. S. Brooks) 1927.
6 (M. C. Z. 17992–7) Margaret River, W. A. (P. J. Darlington) 1931.

The Manjimup specimens constitute the type series. The six toads from the nearby Margaret River are all very young, 12 to 15 mm.; consequently their identification with *brooksi* may be accepted with reservation. They appear to be that species rather than *nichollsi* with examples of which they have been compared.

Pseudophryne nichollsi Harrison

Pseudophryne nichollsi Harrison, 1928, Rec. Austral. Mus. Sydney, **15**, p. 284: Pemberton, Western Australia.

Pseudophryne bibronii Barbour & Loveridge (not of Steindachner), 1929, Copeia, p. 449: (Note on breeding habits).

47 (M. C. Z. 13019–24) Augusta, W. A. (W. S. Brooks) 1927.
2 & ova (M. C. Z. 13032–34) Warren River, W. A. (W. S. Brooks) 1927.
19 (M. C. Z. 13097–110) Manjimup, W. A. (W. S. Brooks) 1927.
44 (M. C. Z. 18276–300) Pemberton, W. A. (W. E. Schevill) 1931.

The Pemberton series are topotypes of this distinct little toad which agrees with *semimarmorata* in the absence of light spots on the hind arms, groin, or anal region; there are, however, a pair of white spots on the breast, another pair at the junction of the thigh and tibia, and on the upper surface of the foot, these appear to be almost invariably present but in ten young Augusta frogs those on the breast are absent. The tip of the fourth toe of the adpressed hind limb reaches to the temple or the eye. The largest specimen (No. 18276) measures 25 mm.

Of the topotype series Mr. Schevill has noted: "Taken in karri forest, near Pemberton, November, 1931. Generally found under logs or stones, but always in moist places, frequently in nests of Myrinecia; when disturbed, habitually lay on back, exhibiting the brightly colored underparts, conspicuous with their patches of brilliant yellow and dark blue."

Pseudophryne guentheri Boulenger

Pseudophryne guentheri Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 279, pl. xviii, fig. 2: Swan River, Western Australia.

39 (M. C. Z. 18326–50) Bruce Rock, W. A. (G. E. Nicholls) 1931.
1 (M. C. Z. 18351) Dalgaranger Station, W. A. (G. E. N.) 1931.
2 (M. C. Z. 18352–3) Pindawa, near Canna, W. A. (Harvard Exped.)
8 (M. C. Z. 18354–61) Mullewa, W. A. (Harvard Exped.) 1931.
Dalgaranger Stn. is some fifty miles N. E. of Yalgoo.

For remarks on this species see also *P. australis* and *P. brooksi* which have for long been confused with it.

None of the above has a tarsal tubercle in addition to the pair of *huge* metatarsal tubercles; one (No. 18326) indeed has two supernumerary tarsal tubercles on the left leg only, the right being normal. I attribute this condition to injury or disease and regard *P. mjöbergii* Andersson as distinct. I have no material of typical western *Uperoleia marmorata* with which Harrison (1927, p. 284) thinks it may be synonymous.

In the thirty-nine specimens from Bruce Rocks the tip of the fourth toe of the adpressed hind limb only varies from reaching to the posterior or anterior border of the eye in females, the nostril in males; in

the Dalgaranger toad to the temple; in the adult female from Pindawa to the shoulder, in the young to the eye; in two female adults from Mullewa to the shoulder or temple, in five young to eye or nostril. The snouts of the Pindawa and Mullewa toads appear to be much more acuminate than the rest of the series, whether this is illusory or whether they represent a distinct race I hesitate to say. The largest females from the Bruce Rock measure 34 mm.

Glauertia russelli Loveridge (See Plate, figs. 1–3)

Glauertia russelli Loveridge, 1933, Occ. Papers Boston Soc. Nat. Hist., **8**, p. 89: Creek near Gascoyne River, Landor Station, Western Australia.

6 (M. C. Z. 19424–9) Mr. Gascoyne R., W. A. (L. Glauert) 1933.

These paratypes are of a genus and species of web-footed, myrmecophagous, rather Brevicipitid-like toads allied to Pseudophryne.

Notaden bennetti Günther

Notaden bennetti Günther, 1873, Ann. Mag. Nat. Hist. (4), **11**, p. 349: Castlereagh River, New South Wales.

1 (M. C. Z. 3607) Moree, N. S. W. (Australian Mus.) 1914.

This single specimen of the Holy Cross Toad measures 38 mm.

Myobatrachus gouldii (Gray)

Breviceps gouldii Gray, 1841, in Grey's Journ. Exped. Discov. Western Australia, **2**, p. 448, pl. i, fig. 1: Western Australia.

4 (M. C. Z. 18362–5) Near Perth, W. A. (G. E. Nicholls) 1931.

Of these four topotypes, the largest (No. 18362) measures 36 mm.

HYLIDAE

Hyla gracilenta Peters

Hyla gracilenta Peters, 1870, Monatsb. Akad. Wiss. Berlin, 1869 (1870), p. 789: Port Mackay, Queensland. Garman, 1901, Bull. Mus. Comp. Zoöl., **39**, p. 14.

Hyla luteiventris Ogilby, 1907, Proc. Roy. Soc. Queensl., **20**, p. 31: Brisbane, Queensland.

1 (M. C. Z. 2318) Cooktown, Q. (E. A. C. Olive) 1896.
2 (M. C. Z. 2762) Mossman, Q. (J. C. Kershaw) 1912.
1 (M. C. Z. 18001) Lankelly Creek, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18487) Lake Barrine, Q. (W. F. Schevill) 1932.

H. luteiventris appears to have been described as a result of an inadequate appreciation of the range of variation of this species and probably a different method of measuring the length of the snout, *i.e.* from the anterior border of the eye instead of from the nostril.

All five specimens differ from Boulenger's (1882, p. 383) description in that the snout (from the nostril) is shorter (not "as long as") the diameter of the orbit, the latter equals the distance from its anterior border to the nostril; the tibio-tarsal articulation of the adpressed hind limb reaches from the nostril to just beyond the end of the snout. They all lack the white streak whose presence Boulenger supposed characterized *gracilenta* and whose absence in the allied *chloris* Boulenger was considered as important by that author. In the frogs from Carrington and Malanda referred to by Andersson (1916, p. 15) the canthal streak was also absent. Fletcher (1893–4, p. 526) has made some useful comments on the status and distribution of *chloris*. The largest frog (No. 18487) measures 46 mm.

"Excepting granular surfaces on under side of thighs and belly, all the granular parts of the skin were bright green; the remainder, concealed when the animal crouched at rest, were bright yellow—a little paler on the belly and throat." (W. E. S.)

Hyla dayi Günther

Hyla dayi Günther, 1897, Novitates Zoöl., **4**, p. 406: Bartle Frere Mountains, Queensland.

Hyla krefftii Barbour (not of Günther), 1914, Proc. Biol. Soc. Washington, **27**, p. 202.

Hyla tympanocryptis Andersson, 1916, Svenska Vetensk.-Akad. Handl., Stockholm, **52**, No. 9, p. 19, pl. i, figs. 7a–e: Malanda, Queensland.

1 (M. C. Z. 4195) Kuranda, Q. (H. L. Clark) 1913.

This frog, originally referred to *krefftii* but with evident misgivings, comes from a locality twenty miles inland from Cairns and less than forty miles from the type localities of both *dayi* and *tympanocryptis*.

The vomerine teeth extend further forward between the choanae than shown in Andersson's figure; the position of these teeth help to differentiate *dayi* from *gracilenta* for in our specimens of the latter the

vomers lie between the choanae. The only character in which *tympanocryptis* appears to differ from *dayi* is in its finely granular surface of the dorsal skin. Our Kuranda frog agrees with Andersson's in possessing this granular surface, and I suggest that the type of *dayi* had it masked by the state of preservation which caused Günther to describe it as "smooth above." The tibio-tarsal articulation of the adpressed hind limb extends beyond the end of the snout. Total length 30 mm.

The relationship between *H. dayi* and Boulenger's *H. fallax* from New Guinea is very close and would appear worthy of investigation.

Hyla caerulea (Shaw)

Rana caerulea Shaw, 1790, in White's Journ. Voy. N. S. Wales, App., p. 248, pl. New South Wales (presumably, not stated).

Hyla irrorata De Vis, 1884, Proc. Roy. Soc. Queensl., **1**, p. 128: Gympie, Queensland.

Hyla gilleni Spencer, 1896, in Rep. Horn Sci. Exped., **2**, p. 173, pl. xv, figs. 14–17: Alice Springs, Central Australia.

Hyla caerulea Garman, 1901, Bull. Mus. Comp. Zoöl., **39**, p. 14. Barbour, 1914, Proc. Biol. Soc. Washington, **27**, p. 201.

4 (M. C. Z. 874, 1926) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 2316) Port Bowen, Q. (Dr. Woodworth) 1896.
3 (M. C. Z. 2529–31) Mer Id., Torres Straits (H. L. Clark) 1913.
1 (M. C. Z. 3701) Brisbane, Q. (Queensland Mus.) 1914.
1 (M. C. Z. 18002) Townsville, Q. (Dr. Woodworth) 1896.
1 (M. C. Z. 18003) Darwin, N. T. (J. Litchfield) 1929.
2 (M. C. Z. 18004–5) Burnett River, Q. (T. L. Bancroft) 1932.
11 (M. C. Z. 18006–15) MacPherson Range, Q. (P. J. Darlington) 1932.
5 (M. C. Z. 18016–20) Coen, Cape York, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18488) Towri Stn., nr. Richmond, Q. (W. E. Schevill) 1932.

I follow Fry (1912, p. 100) in referring *irrorata* to the synonymy of *caerulea*. The light spots at the angle of the mouth which Fry could not find in his material are present in some of our Queensland series though definitely this species and not *infrafrenata*. De Vis' type was evidently a juvenile measuring "32 lines." *H. gilleni* Spencer is so obviously specifically identical with *irrorata* as to stand or fall with that species. It is interesting to note, however, that De Vis states of his *irrorata* that the digital disks are two-fifths the diameter of the tympanum, while Spencer states of *gilleni* that they are half to two-thirds. The figure of the latter, however, shows some disks as large

as the tympanum and it may be postulated that some are contracted from immersion in the spirit of which he writes.

In our series the fingers are from a third to half webbed, even in the Sydney specimens which may be considered topotypes, but rather less in the Mer Island frogs; the tibio-tarsal articulation of the adpressed hind limb marks the tympanum or the eye; I fail to discern the "distinct parotid" mentioned by Boulenger (1882, p. 346). Lateral white spots are absent in all except the large Coen frog, a white line along the heel appears to be largely a juvenile character being present in the young and absent in the adults from Sydney, MacPherson Range, and Merauke, New Guinea; they may, however, persist in adults at Port Bowen and Coen.

Dr. H. L. Clark supplies the following information as to the color in life of the frog from Darwin. "Above, bright green with a tendency to yellow on the upper surface of ankles and feet. Below, breast white, becoming greenish on chin and lower lip but reddish violet posteriorly and on the inner surface of the thighs; soles of hands and feet red violet; inner and outer portions of the inner (lower) surface of tibia yellow. Taken at Myilly Point, Darwin, 30. vi. 1929." (H. L. C.)

The largest specimens (M. C. Z. 18003, 18016) measure 81 mm. but are surpassed by a New Guinea frog (No. 12151) measuring 86 mm.

The Coen frogs were "Found in rain gutters during the day; squatting on verandah rails and fence posts at night." (P. J. D.) The Towri specimen "in a bore drain." (W. E. S.)

Hyla eucnemis Lönnberg

Hyla eucnemis Lönnberg, 1900, Ann. Mag. Nat. Hist. (7), **6**, p. 579: Sattelberg, 800 metres, New Guinea.

Hyla serrata Andersson, 1916, Svenska Vetensk.-Akad. Handl. Stockholm, **52**, No. 9, p. 17, pl. i, fig. 6: Carrington; Malanda and Atherton, Queensland.

1 (M. C. Z. 18021) Lankelly Creek, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18022) Rocky Scrub, Q. (P. J. Darlington) 1932.
6 (M. C. Z. 18023–8) Millaa Millaa, Q. (P. J. Darlington) 1932.
22 (M. C. Z. 18029–39) Mt. Spurgeon, Q. (P. J. Darlington) 1932.

The first two localities are in the McIlwraith Range, the third on the Atherton Tableland. The series from Mt. Spurgeon were taken between three and four thousand feet. "On the solid stone walls of a long tunnel made by miners to deflect a stream; a very damp, cool, and dark habitat." (P. J. D.)

Second and fourth fingers webbed to the disks; toes fully webbed; a serrated fringe along the hinder edge of forearm and foot characterize this frog so well figured by Andersson. That *serrata* is a synonym of *eucnemis* I have no doubt. The largest specimen (No. 18029) measures 81 mm. and is, therefore, by far the finest example recorded.

Hyla peronii (Tschudi)

Dendrohyas peronii Tschudi, 1838, Classif. Batr., p. 75: New Holland (i.e. Australia).
Hyla rothi De Vis, 1884, Proc. Linn. Soc. N. S. W., **9**, p. 66: Mackay, Queensland.

2 (M. C. Z. 1602) Melbourne, V. (Prof. F. Müller) N. D.
1 (M. C. Z. 1928) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 3587) Woonoona, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 3588) Eidsvold, Q. (Australian Mus.) 1914.

Woonoona is near Bulli. The series appears to be quite typical. The largest specimen (No. 3587) measures 56 mm.

Hyla bicolor (Gray)

Eucnemis bicolor Gray, 1842, Zoöl. Miscellany, p. 57: Port Essington, Northern Territory.
Hylella bicolor Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 421.

2 (M. C. Z. 3625–6) Nambucca, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 18489) Bellenden Ker Range, Q. (W. E. Schevill) 1932.

Noble (1931, p. 508) has pointed out the polyphyletic nature of the assemblage of frogs grouped under Hylella on account of the loss of vomerine teeth. In view of the recent accumulation of information as regards the value of this character which in other genera, such as Crinia, is not even of specific importance (not to mention several African genera where vomerine teeth are present or absent) it is clear that Hylella can no longer be maintained. It is of interest to note that the alcohol-preserved frogs are smooth above, even under a strong lens, while the formalin-preserved specimen is strongly granular above. The larger specimens (Nos. 3625 and 18489) measure 26 mm.

Hyla phyllochroa Günther

Hyla phyllochroa Günther, 1863, Proc. Zoöl. Soc. London, p. 251, pl. xxx, fig. C: Sydney and Errumanga, New South Wales.

1 (M. C. Z. 3608) Woodford, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 18040) Gorge, Hornsby, N. S. W. (P. J. Darlington) 1931.
1 (M. C. Z. 18526) Blackheath, N. S. W. (P. J. Darlington) 1932.
1 (M. C. Z. 19253) National Park, Q. (F. N. Blanchard) 1928.

Woodford and Blackheath are both in the Blue Mountains, the latter at an altitude of about 3,000 feet. The largest specimen (No. 3608) measures 41 mm.

Hyla rubella Gray

Hyla rubella Gray, 1842, Zoöl. Miscellany, p. 57: Port Essington, Northern Territory.

2 (M. C. Z. 3596–7) Eidsvold, Burnett R., Q. (Austral. Mus.) 1914.
4 (M. C. Z. 18041–4) Whin Creek, Roeburne, W. A. (G. E. Nicholls) 1931.
2 (M. C. Z. 18045–6) Gascoyne, W. A. (G. E. Nicholls) 1931.
1 (M. C. Z. 18047) Meekatharra, W. A. (Harvard Exped.) 1931.
3 (M. C. Z. 18048–50) Yandil, W. A. (P. J. Darlington) 1931.
2 (M. C. Z. 18051–2) Lake Barrine, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18053) near Geraldton, W. A. (P. J. Darlington) 1931.

The vomerine teeth are constantly posterior to the choanae; in formalin preserved specimens it will be seen that the fifth toe is actually webbed to the base of the disk, a condition which is apt to be masked in alcohol-preserved frogs; the tibio-tarsal articulation of the adpressed hind limb marks the axilla or tympanum. The largest specimen (No. 18051) measures 36 mm.

"The frogs from Yandil, near Wiluna, were taken under stones, beside a waterhole, in a creek bed." (P. J. D.)

Hyla dentata Keferstein

Hyla dentata Keferstein, 1868, Nachr. Ges. Göttingen, p. 329: New South Wales.

2 (M. C. Z. 876, 1934) Sydney, N. S. W. (Göttingen Mus.) 1885.
1 (M. C. Z. 3609) Near Bulli, N. S. W. (Australian Mus.) 1914.

Keferstein's type material consisted of a single frog collected by Dr. Schuette so that though No. 876 was received prior to 1885 it is not a cotype. Moreover both specimens were received as *H. krefftii* Günther and are only now correctly identified. In all the tibio-tarsal articulation of the adpressed hind limb marks the tympanum or the eye. The largest specimen (No. 3609) measures 36 mm.

Hyla citropus (Tschudi)

Dendrohyas citropa (Péron ms. in) Tschudi, 1838, Classif. Batr., p. 75: Port Jackson, New South Wales.

4 (M. C. Z. 9581–4) Hornsby, N. S. W. (W. H. Rosenberg) 1924.

Of these frogs, purchased and presented by Dr. T. Barbour, the largest specimen (No. 9581) measures 54 mm.

Mr. W. E. Schevill also collected a pair on the Stanwell Park Creek, N. S. Wales. These formed the subject of a note by Kinghorn (1932, p. 362) on the sexual dichromatism of this species as displayed by living specimens.

Hyla parvidens Peters

Hyla parvidens Peters, 1874, Monatsb. Akad. Wiss. Berlin, p. 620: Port Phillip, Victoria.

2 (M. C. Z. 9585–6) Botany Bay, N. S. W. (W. F. H. Rosenberg) 1924.

These frogs, apparently a male and female, were received from Rosenberg identified as *H. krefftii* Günther. They differ from that species, however, in their less conspicuous vomerine teeth, smaller size, and different coloring. It would appear that they cannot be regarded as a race of *jervisiensis*, of which I consider *krefftii* a synonym, on geographical grounds.

The outer finger is one third webbed; outer toe webbed to the disk; the digital disks are as large as the tympanum; the tibio-tarsal articulation of the adpressed hind limb marks the eye.

Number 9585 is gray, inconspicuously flecked with black above; a brown streak from the nostril through the eye to the tympanum; a white band bordering the upper lip extends to the shoulder; hinder sides of thighs pure white except in the vicinity of the anus. Below, immaculate. The larger specimen (No. 9585), a gravid female, measures 35 mm.

It may be noted that the type of *parvidens* measured 33 mm. and was said to be yellowish above. It is probable that this frog has frequently been mistaken for the young of *krefftii*, for in coloration it closely approximates to Duméril & Bibron's description of *jervisiensis*.

Hyla jervisiensis Duméril & Bibron

Hyla jervisiensis Duméril & Bibron, 1841, Erpét. Gén., **8**, p. 580: Jervis Bay, New South Wales.

Hyla krefftii Günther, 1863, Ann. Mag. Nat. Hist. (3), **11**, p. 28, pl. iv, fig. C: Sydney, New South Wales.

Hyla calliscelis Peters, 1874, Monatsb. Akad. Wiss. Berlin, p. 620: Adelaide, South Australia.

1 (M. C. Z. 369) Australia (No history) N. D.
1 (M. C. Z. 3603) Naroubra, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 19053) South Australia (Australian Mus.) 1933.
1 (M. C. Z. 19054) Launceston, T. (Australian Mus.) 1933.
59 (M. C. Z. 19339–50) Launceston, T. (E. O. G. Scott) 1933.
2 (M. C. Z. 19351–2) Stanley, T. (E. O. G. Scott) 1933.
5 (M. C. Z. 19353–7) Franklin, T. (E. O. G. Scott) 1933.

Number 369, an old, somewhat soft and faded specimen, has been in the collection for half a century or so under the name of *jervisiensis*. Number 3603 was received as *krefftii*. We can be definitely certain that both are conspecific and represent *krefftii*. Yet No. 369 shows the glandular fold at the corner of the mouth (which characterizes *jervisiensis*) very clearly and on turning to the original description of *jervisiensis* we find that there is nothing but its grey coloration to separate it from *krefftii*. The type of the former measured 47 mm. and Boulenger gives the length of *krefftii* also as 47 mm. Fletcher records that he sought for *jervisiensis* at Jervis Bay but only found *krefftii*. When a species has been described from such an accessible locality as Jervis Bay and then remains unknown except for the type for nearly a century we are justified in assuming that there is something misleading about the description. I postulate, therefore, that the type of *jervisiensis* was somewhat faded and relegate *krefftii* to the synonymy. Anyone questioning this action is referred to the original descriptions and care should be taken to eliminate *parvidens* and *dentata* which occur in these regions and are closely allied forms.

Boulenger (1882, p. 407) referred certain frogs from King George's Sound, south Western Australia, to *calliscelis* and made *calliscelis* a *var.* of *ewingii*. Without expressing an opinion as to the identity of

these western frogs which may represent a form of *jervisiensis*, our No. 19053 is more nearly topotypic of *calliseelis* and agrees with the description of that species. Fry (1915, p. 84) professed to separate *calliscelis* and *krefftii* as follows:

Groin and hinder thigh with accentuated purple blotches. . . *calliscelis.*
Groin and thighs yellowish with faint brown speckles . . . . . *krefftii.*

By applying this to our material the New South Wales specimens answer to *krefftii*, the South Australian to *calliscelis* but the Launceston series, or the Franklin series, show both types and every intergradation between them. If large series could be obtained from South Australia and New South Wales, I imagine that they would confirm my action in synonymising *calliscelis.*

Fletcher (1897, p. 669) followed by Fry (1915, p. 82) regarded *krefftii* as a 'variety' of *ewingii.* While fully admitting the very close relationship between the *ewingii* group and the *jervisiensis-parvidens* group, I cannot treat *jervisiensis* as a race of *ewingii* for reasons of distribution.

The outer finger is a quarter to one-third webbed; outer toe webbed to the disk or a little short of the disk; the median digits possess disks as large as the tympanum; the tibio-tarsal articulation marks the orbit, or just anterior to it in a few males, just posterior to it in a few females.

A broad, brown, dorsal band of somewhat irregular outline connects the eyelids and extends posteriorly to the anus, sometimes indistinct; a brown streak from the nostril through the eye to the shoulder is bordered above and below by lighter, in the young the lower shows as a silvery-white streak along the upper lip to the base of the forearm, usually less prominent in adults; hinder side of thighs *bright yellow* (in fresh material) with, or without brown flecks, blotches or streaks; similar blotches usually present on the groin and hinder part of flanks. The largest male (No. 19339) measures 38 mm., largest female (No. 19353) 45 mm.

Hyla ewingii ewingii Duméril & Bibron

Hyla ewingii Duméril & Bibron, 1841, Erpét. Gén., **8**, p. 597: Tasmania.

1 (M. C. Z. 19252) National Park, T. (F. N. Blanchard) 1928.
5 (M. C. Z. 19358–62) St. Peter's River, T. (E. O. G. Scott) 1933.
14 (M. C. Z. 19363–9) Dunorlan, T. (E. O. G. Scott) 1933.

The outer finger usually with the merest rudiment of web, at most only a quarter webbed; outer toe webbed to the disk or a little short

of the disk; median digital disks as large as, or slightly smaller than, the tympanum; the tibio-tarsal articulation of the adpressed hind limb marks the orbit or more usually just beyond; skin of back smooth (in formalin) or with very small, pimple-like warts (in alcohol). Above, grey, forehead to interorbital region lighter, a more or less well-defined silvery streak from the upper lip to the base of the forearm; a broad, brown, dorsal streak from the interorbital region to above the anus; hinder side of thighs uniformly *red* (in fresh material) or with a few large spots and streaks. Largest male (No. 19358) measures 32 mm., largest female (No. 19252) 37 mm.

It will thus be seen that but for a few average differences the only straight-cut characters for separating this species from the preceding is size and the different coloration of the hinder side of the thighs in living material.

Hyla ewingii verreauxii Duméril

Hyla verreauxii A. Duméril, 1853, Ann. des Sci. Nat., p. 171: Australia.
Hyla ewingii var. *orientalis* Fletcher, 1897, Proc. Linn. Soc. N. S. W., **22**, p. 670: New South Wales.

1 (M. C. Z. 3594) Smithfield, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 3595) Berridale, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 18080) Mt. Kosciusko, N. S. W. (W. M. Wheeler) 1931.
1 (M. C. Z. 19056) Mt. Kosciusko, N. S. W. (Australian Mus.) 1933.
3 (M. C. Z. 19057–9) Tamworth, N. S. W. (Australian Mus.) 1933.
1 (M. C. Z. 19060) Glen Innes(?), N. S. W. (Australian Mus.) 1933.
3 (M. C. Z. 19061–3) Warragul, V. (Australian Mus.) 1933.

The distribution of this race is probably confined to New South Wales and Victoria at altitudes below 5,000 feet. Both Nos. 18080 and 19056 are from 5,000 feet on Mt. Kosciusko.

Numbers 3594-5 were received from the Australian Museum after the late Mr. D. B. Fry had completed his revision of the *ewingii* group and had identified them as *orientalis*. On comparing them with the original description of *verreauxii*, a species which was overlooked by Boulenger (1882) and Nieden (1923), I find that they are so fully in agreement as to make one reasonably confident that they represent the same frog.

The outer fingers are without web; outer toes three-quarters webbed or occasionally even to the disk; the median digital disks smaller than the tympanum; tympanum distinct; the tibio-tarsal articulation of

the adpressed hind limb marks the eye in every specimen. The largest specimen (No. 3594) measures 32 mm.

This race differs from the typical form by its smooth, dorsal skin; by the presence of brown spots on hinder flanks but not hinder side of thighs and by the broad, brown band which commences in the interorbital region but is separated posteriorly by a light vertebral line (such a band is common to many allied species such as *jervisiensis* and *dentata*). In having the dorsal band interrupted down the centre these frogs closely resemble *parvidens*, from which species they may be readily distinguished by the smaller digital disks and the absence of digital webbing.

Hyla ewingii alpina Fry

Hyla ewingii var. *alpina* Fry, 1915, Proc. Roy. Soc. Queensl., **27**, p. 79, fig. 4, pl. iii, fig. 2: Mt. Kosciusko, Monaro district, New South Wales.

1 (M. C. Z. 18054) Barrington Tops, N. S. W. (P. J. Darlington) 1932:
1 (M. C. Z. 18055) Dead Horse Ridge, N. S. W. (W. E. Schevill) 1931:
39 (M. C. Z. 18056–69) S. of Etheridge Range, N. S. W. (W. E. Schevill) 1931.
27 (M. C. Z. 18070–9) Daner's Gap, N. S. W. (W. E. Schevill) 1931.
13 (M. C. Z. 18516–25) Hartley Vale, N. S. W. (P. J. Darlington) 1932.
Cotype (M. C. Z. 19055) Mt. Kosciusko, N. S. W. (T. H. Johnston) 1933.

Fry gives the distribution of this race as Mt. Kosciusko above 5,200 feet and this is borne out by our material. The cotype is from 7,000 feet; Dead Horse Ridge is 6,600 feet; south of Etheridge Range, 6,500 feet; Daner's Gap, 5,400 feet. Two frogs from Mt. Kosciusko at 5,000 feet are clearly referable to *H. e. verreauxii*. The frogs from Barrington Tops (5,000 feet) and Hartley Vale (*circa* 2,500 feet) in the Blue Mountains are intermediates between *alpina* and *verreauxii* agreeing with the former in their larger size and striking lateral blotches, with the latter in their smooth integumen.

The outer fingers are without web; outer toes three-quarters webbed, in one old individual (No. 18055) and in the cotype right to the disk; the median digital disks are smaller than the tympanum; tympanum often very indistinct; the tibio-tarsal articulation of the adpressed hind limb marks the tympanum or the eye. The largest specimen (No. 18055) measures 46 mm.

This race differs from the typical form and from *verreauxii* in its larger size, more warty integumen, and numerous prominent, large, black blotches on the sides and groin but not on the hinder aspect

of the thigh excepting in the frog from Barrington Tops. The Warragul frogs, referable to *verreauxii*, approach *alpina* in the size of their lateral blotches. The Barrington Tops frog, a year after capture and while still in formalin solution, displays on the hinder side of the thigh a deep black streak and some dusky flecks on a yellow ground reminiscent of the markings of *H. jervisiensis*. Most of the Hartley Vale frogs are juvenile, yet adult and young alike show vermilion patches on the groin, inner angle of the knee and upper angle of the ankle joint. It may be that two forms are confused in the above series.

Number 18055 was found "under a stone on a very dry ridge." (W.E.S.)

Hyla adelaidensis Gray

Hyla adelaidensis Gray, 1841, in Grey's Journ. Exped. Discov. West. Australia, **2**, p. 447, pl. viii, fig. 2: Western Australia.

3 (M. C. Z. 3620–2) Western Australia (Australian Mus.) 1914.
13 (M. C. Z. 12967–71) Claremont, W. A. (W. S. Brooks) 1927.
23 (M. C. Z. 12972–6) Spectacle Swamp, W. A. (G. E. Nicholls) 1922.
23 (M. C. Z. 12977–81) Manjimup, W. A. (W. S. Brooks) 1927.
7 (M. C. Z. 12982–5) Near Rockingham, W. A. (W. S. Brooks) 1927.
6 (M. C. Z. 12986–91) Spectacle Swamp, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 12992) Near Mt. Melville, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 18081) Swan View, Perth, W. A. (Harvard Exped.) 1931.
2 (M. C. Z. 18082–3) Darling Range, W. A. " "
1 (M. C. Z. 18084) Margaret River, s. w. W. A. " "
4 (M. C. Z. 18085–8) Pemberton, W. A. " "
5 (M. C. Z. 18089–93) Perth, W. A. " "

The frogs in this series are characterized by their acuminate snouts; outer finger without, or with the merest trace of, web; outer toe webbed almost to (young) or to (adult) the disk; the tibio-tarsal articulation of the adpressed hind limb marks the eye or end of the snout except in one adult from Pemberton where it goes a trifle beyond.

All the frogs collected by Mr. W. S. Brooks are young, of those taken at Claremont, six miles west of Perth, on January 7, 1927, he notes: "Back light metallic gold, sometimes greenish gold, one specimen golden green; streak on side of head bronze; back of thighs spotted with bright orange, black margins. Under surface creamy yellow white." In coloration (after preservation in alcohol) the blue gray backs of the young (taken in grass on the edge of a swamp at Manjimup) are reminiscent of preserved examples of *Hyla bicolor* but may be distinguished by their elongate and more acuminate snouts.

Hyla aurea (Lesson)

Rana aurea Lesson, 1830, 'Zoologie', in Duperrey's Voy. autour du Monde . . . sur . . . "La Coquille", **2**, p. 60, pl. vii, fig. 2: Macquarie and Bathurst Rivers, New South Wales.

Hyla aurea var. *cyclorhynchus* Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 411: Western Australia.

Fanchonia elegans Werner, 1893, Zoöl. Anz., **16**, p. 82: Tropical Africa. (error)

1 (M. C. Z. 1927) Sydney, N. S. W. (Göttingen Mus.) 1885.
8 (M. C. Z. 12920–4) Balcatta Beach, W. A. (W. S. Brooks) 1927.
133 (M. C. Z. 12925–35) Causeway, W. A. (W. S. Brooks) 1927.
5 (M. C. Z. 12936–40) Claremont, W. A. (W. S. Brooks) 1927.
12 (M. C. Z. 12941–5) Near Perth, W. A. (W. S. Brooks) 1927.
2 (M. C. Z. 12946–7) Munger Lake, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 12948) Swan View, W. A. (W. S. Brooks) 1927.
2 (M. C. Z. 12949–50) Spectacle Swamp, W. A. (W. S. Brooks) 1927.
8 (M. C. Z. 12951–5) Manjimup, W. A. (W. S. Brooks) 1927.
2 (M. C. Z. 12956–7) Pemberton, W. A. (W. S. Brooks) 1927.
1 (M. C. Z. 18094) Augusta, W. A. (W. S. Brooks) 1927.
5 (M. C. Z. 18095–9) Rottnest Id., W. A. (P. J. Darlington) 1931.
5 (M. C. Z. 18100–4) Merredin, W. A. (G. E. Nicholls) 1931.
9 (M. C. Z. 18105–13) Wallcliffe, W. A. (W. E. Schevill) 1931.
1 (M. C. Z. 19251) Millgrove, V. (F. N. Blanchard) 1928.
♂ (M. C. Z. 19332) Tasmania. (T. M. S. English) 1901–03.
♀ (M. C. Z. 19370) Stanley, T. (E. O. G. Scott) 1933.
Wallcliffe is near Margaret River, Southwest of Division.

The name *cyclorhynchus* was proposed by Boulenger for a pair of frogs whose lower surfaces were densely reticulated with black. Somewhat similar variants occur in our Merredin series in which normal frogs are also present; whether or not *cyclorhynchus* is within the range of variation of *aurea* I hesitate to say on the basis of such slender data.

In reality the frogs of this series do not differ from *adelaidensis* in the amount of digital web for the outer finger is without web, or has only the merest trace of web; similarly the web on the outer toe of the young does not reach to the disk though it does so in the adults; the tibio-tarsal articulation of the adpressed hind limb barely reaches the eye, or extends just beyond the eye. The much larger disks of the females presumably have developed to support the united weight of a pair when in embrace. The largest specimen (No. 18113) measures 86 mm.

"The large series of young from Causeway, Swan River, were taken at the edge of a marsh in January; the adults from Pemberton in the

water near the edge of a dammed-up pond where they had assembled for breeding, some being in embrace when captured, March, 1927." (W.S.B.)

"Three pairs of the Wallcliffe frogs, taken on November 6, 1931, were in axillary embrace. The manus pressed deeply into the side of the female, fingers loosely clenched except the first, which remained extended. They were not taken in the river, which is tidal at Wallcliffe." (W.E.S.)

Hyla blandsuttoni Procter

Hyla blandsuttoni Procter, 1924, Proc. Zoöl. Soc. London, p. 1128, pl. iii, fig. 4: "? Queensland" (purchased from a dealer).

1 (M. C. Z. 3525) Sydney, N. S. W. (T. Steel) 1914.

This frog, though in the collection under the name of *aurea* for nearly two decades, differs from our Sydney example of that species in just those characters by which the late Miss Procter differentiated the species she named *blandsuttoni*. The canthus is not so strongly marked as in her living type, however, but it possesses the dorso-lateral glandular fold which is characteristic of *aurea*. It differs from our Sydney specimen of *aurea* in the rounded, somewhat transverse, groups of vomerine teeth; in its more slender toes and smaller, though more distinct, disks; and in the absence of an outer metatarsal tubercle. Some faintly vein-like dark mottling is present on the back. Total length 59 mm.

Hyla obsoleta Lönnberg

Hyla obsoleta Lönnberg, 1900, Ann. Mag. Nat. Hist. (7), **6**, p. 580: Simbang, 50 metres, New Guinea.

Hyla nannotis Andersson, 1916, Svenska Vetensk.-Akad. Handl., Stockholm, **52**, No. 9, p. 16, pl. 1, figs. 5a–e: Tully River, North Queensland.

19 (M. C. Z. 18114–25) Mt. Spurgeon, Q. (P. J. Darlington) 1932.

Taken at an altitude of about 4,000 feet, these frogs tally so closely with Lönnberg's description of *obsoleta* and also with Andersson's description and figure of *nannotis* as to leave no doubt in my mind that the latter is a synonym of the former. True the former is said to have the tympanum hidden while in the latter it is said to be very small, about a quarter of the diameter of the eye, its upper margin

indistinct. The series from Mt. Spurgeon, however, present both these conditions. Both descriptions were based on juvenile individuals of 34 and 45 mm. respectively; while most of our specimens are also young, the largest measures 67 mm.

Hyla lesueurii Duméril & Bibron

Hyla lesueurii Duméril & Bibron, 1841, Erpét. Gén., **8**, p. 595: Port Jackson, New South Wales.

Pelodytes affinis Gray, 1842, Zoöl. Miscellany, p. 56: Port Essington, Northern Territory.

Hyla nigrofrenata Günther, 1867, Ann. Mag. Nat. Hist. (3), **20**, p. 56: Cape York, Queensland.

Hyla vinosa Lamb, 1911, Ann. Queensl. Mus., No. 10, p. 27: Ithaca Creek, Brisbane, Queensland.

Hyla tornieri Nieden, 1923, Das Tierreich, **46**, Anura, **1**, p. 228 (n.n. for *affinis* Gray, preoccupied).

2 (M. C. Z. 1929) Sydney, N. S. W. (Göttingen Mus.) 1885.
2 (M. C. Z. 3598–9) Norton's Basin, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 3606) Brisbane, Q. (Australian Mus.) 1914.
4 (M. C. Z. 18126) Salisbury, N. S. W. (P. J. Darlington) 1932.
5 (M. C. Z. 18127–31) Millaa Millaa, Q. (P. J. Darlington) 1932.
6 (M. C. Z. 18132, 18496–500) Lake Barrine, Q. (P. J. D. & W. E. S.) 1932.
1 (M. C. Z. 18490) Bunya Mountains, Q. (W. E. Schevill) 1932.
1 (M. C. Z. 18491) Mundubbera, Q. (W. E. Schevill) 1932.
1 (M. C. Z. 19250) National Park, Q. (F. N. Blanchard) 1928.

Pelodytes affinis Gray, preoccupied by *affinis* Spix, so renamed *tornieri* by Nieden, was based on a male; *nigrofrenata* Günther on a female. The alleged difference was that the tibio-tarsal articulation of the adpressed hind limb reached the nostril or tip of the snout in *affinis*, far beyond the tip of the snout in *nigrofrenata*. I have examined one of the frogs referred to *affinis* by Andersson (1913, p. 24) and find it to be *latopalmata* (Günther).

The very small outer metatarsal tubercle is sometimes so inconspicuous in the above series as to be almost absent. The Sydney frogs, which are topotypes of *lesueurii*, have the first finger slightly shorter, or longer, than the second; in the Millaa Millaa series, which may be regarded as topotypes of *nigrofrenata*, the first finger is equal to, or a trifle longer, or shorter, than the second; the tibio-tarsal articulation of the hind limb reaches the eye in the young, or far beyond the end

of the snout in adults in the series as a whole or in the Salisbury series alone. As to the suggestion that northern frogs attain a greater size, it will be observed that Boulenger gives 65 mm. as total length for *lesueurii* of New South Wales and 41 mm. for *nigrofrenata*, 35 mm. for *affinis* from Port Essington. While several of our Lake Barrine frogs measure 64 mm., one (No. 18126) from New South Wales measures 63 mm. These large measurements are for females, the males being much smaller. Our smallest specimen (No. 18491), taken in March, measures 16 mm. Thus the principal alleged differences between *lesueurii* and *nigrofrenata* are disposed of and I fail to find any stable characters on which to revive the latter as a northern race.

Number 3606 was received as *Phractops alboguttatus*, obviously due to some accident. This frog is practically a topotype of *vinosa* Lamb, which was based on such characters as showed that the author had not had much taxonomic experience. True the groups of vomerine teeth in his type were contiguous while normally they are slightly separated as in our topotype; in the whole series, however, a considerable range of variation is displayed. Lamb compared *vinosa* with *nigrofrenata*, but Fry (1915, p. 84) rated it as a variety of *lesueurii* on the basis of size (the type of *vinosa* measured 52 mm.) and in the belief that Queensland frogs possessed relatively larger disks. While slight differences may occur the impression is mainly illusory as one will find by comparing frogs from Sydney with others of *similar size* from northern Queensland. Northern frogs may be slightly more webbed but so very slightly as to make it impossible to reduce to writing.

Of the Bunya Mountain frog a field note reads: "Taken under the bark of a tree in Wengen Creek, north of Munro's Camp. Even when exposed, it provided an example of perfect camouflage both in color and pattern." (W.E.S.)

Hyla latopalmata (Günther)

Litoria punctata Duméril, 1853, Ann. des Sci. nat., p. 149: Sydney, New South Wales.

Litoria latopalmata Günther, 1867, Ann. Mag. Nat. Hist. (3), **20**, p. 55: Port Denison, Queensland

Hyla dimolops Cope, 1869, Proc. Amer. Phil. Soc., **11**, p. 163: (n.n. for *punctata* Duméril, preoccupied by *punctata* Schneider).

Hyla affinis Andersson (not of Gray), 1913, Svenska Vetensk.-Akad. Handl. Stockholm, **52**, No. 4, p. 24.

1 (M. C. Z. 3618) Norton's Basin, N. S. W. (Australian Mus.) 1914.
1 (M. C. Z. 3619) Eidsvold, Burnett R., Q. (Australian Mus.) 1914.
1 (M. C. Z. 18000) Kimberley Division, W. A. (E. Mjöberg) 1910–1911.
4 (M. C. Z. 18492–5) Rutherford, Sellheim R., Q. (W. E. Schevill) 1932.

Numbers 3618-9 were received as *H. latopalmata.* That the specimen from Norton's Basin, Nepean River, represents *dimolops,* for which search has been made for eighty years, there is no doubt. After comparing it with Duméril's original description (not Boulenger's) the ambiguity is cleared away. Unfortunately in his key, Boulenger (1882, p. 348) stressed Duméril's reference to a little glandular fold; such a fold is present on one side and absent on the other in our Norton's Basin frog, being obviously the result of preservation.

Number 18000 is one of the series of northwestern specimens which Andersson erroneously referred to *affinis* resulting in his claim of a first record for Western Australia. *H. latopalmata* had long been known to occur in Western Australia.

The two largest frogs (Nos. 3618 and 18492) have shorter hind limbs of which the tibio-tarsal articulation only reaches to the nostril while in the other Queensland frogs it extends well beyond the end of the snout. In all the first finger is longer than the second; the tympana are two-thirds the orbital diameter. The largest (No. 18492) measures 39 mm.

I judge that *latopalmata* can best be separated from its near ally *lesueurii* by its narrower head and habit. In addition No. 3618 differs from two *lesueurii* from the same locality in its dorsal punctate blotches; apart from this the markings are strikingly similar and it is not a little surprising to find two such closely related species occurring in the same locality.

Hyla freycineti (Duméril & Bibron)

Litoria freycineti Duméril & Bibron, 1841, Erpét. Gén. 8, p. 504, pl. lxxxviii, fig. 9: Port Jackson, New South Wales.

2 (M. C. Z. 1936) Australia (Göttingen Mus.) 1885.
1 (M. C. Z. 3604) Naroubra Swamps, N. S. W. (Australian Mus.) 1914.

The two specimens poorly localized are also poorly preserved and very young, but appear to be correctly determined; the adult male has the first finger a trifle longer than the second; the tibio-tarsal articulation of the adpressed hind limb reaches the end of the snout, not beyond. Total length 40 mm.

Hyla nasuta (Gray)

Pelodytes nasutus Gray, 1842, Zoöl. Miscellany, p. 56: Port Essington, Northern Territory.

Hyla peninsulae De Vis, 1884, Proc. Roy. Soc. Queensland, **1**, p. 129: Cape York, Queensland.

1 (M. C. Z. 3600) Nambucca River, N. S. W. (Australian Mus.) 1914.
5 (M. C. Z. 18133–7) Darwin, N. T. (H. L. Clark) 1929.
4 (M. C. Z. 18138–41) Coen, Cape York, Q. (P. J. Darlington) 1932.

The first finger is equal to, or longer than, the second; the tibiotarsal articulation of the adpressed hind limb reaches beyond the tip of the snout. Not one of the series is fully grown, the largest (No. 3600) measures 39 mm.

"Found hopping on the ground at night, one was taken at the edge of a brook and another on dry ground at least a hundred yards from the nearest water." (P.J.D.)

RANIDAE

Rana papua papua Lesson

Rana papua Lesson, 1830, 'Zoölogie', in Duperrey's Voy. autour du Monde . . . sur . . . "La Coquille", **2**, p. 59, pl. vii, fig. 1: Waigiou Island, New Guinea. Barbour, 1914, Proc. Biol. Soc. Washington, **27**, p. 201.

Hylorana daemeli Steindachner, 1868, Sitzb. Akad. Wien, **57**, p. 532, pl. c: Cape York, Queensland.

Hylarana nebulosa Macleay, 1877, Proc. Linn. Soc. N. S. W., **2**, p. 135: Cape York, Queensland.

Hyla nobilis De Vis, 1884, Proc. Roy. Soc. Queensl., **1**, p. 129: Cape York, Queensland.

Rana daemeli Garman, 1901, Bull. Mus. Comp. Zoöl., **39**, p. 14.

1 (M. C. Z. 2317) Cooktown, Q. (E. A. Olive) 1896.
2 (M. C. Z. 3532–3) Kuranda, Q. (H. L. Clark) 1913.
9 (M. C. Z. 18142–6) Lankelly Creek, Q. (P. J. Darlington) 1932.
Lankelly Creek is in the McIllwraith Range.

Without venturing an opinion as to the distinctness of *florensis* Boulenger, I have used trinomials because of the action of Mertens (1930, p. 225) in making *florensis* a race of *papua* on the basis of larval dentition as described by Dunn in 1928. The latter author resurrected *florensis* from the synonymy of *papua* to which it had been relegated by Van Kampen (1923, p. 201).

Boulenger (1918, p. 240) revived the name *daemeli* of Steindachner for Queensland frogs which he separates on limb length. According to his definition, however, our halfgrown and juvenile Cooktown and Kuranda specimens would have to be referred to *papua* while the juveniles from Lankelly Creek agree with *daemeli* in the tibio-tarsal articulation reaching to the eye, the adults from the same locality have the tibio-tarsal articulation of the adpressed hind limb marking the nostril, end of snout, or beyond as in *papua*.

Van Kampen (1923, p. 206) retains *daemeli* as distinct though with misgivings for he says: "perhaps identical with *R. papua*, from which, however, it seems to be distinct by broader dorsolateral folds." As I fail to observe any such distinction in either our Australian or larger series of New Guinean specimens, I restore *daemeli* to the synonymy of *papua*.

While the majority of our Queensland frogs are juvenile, the largest specimens (Nos. 18142-3) measure 85 mm.

BREVICIPITIDAE[1]

Phrynomantis ornata (Fry)[2]

Austrochaperina ornata Fry, 1912, Rec. Austral. Mus. Sydney, **9**, p. 91, fig. 38: 25 miles inland from Cairns, and Russell River, northeast Queensland.

Phrynixalus reginae Andersson, 1916, Svenska Vetensk.-Akad. Handl., Stockholm, **52**, No. 9, p. 4, figs. 1a–d: Malanda and Cedar Creek, northern Queensland.

3 (M. C. Z. 4257–9) Kuranda, Q. (W. M. Wheeler) 1916.
1 (M. C. Z. 17805) Malanda, Q. (E. Mjöberg) 1913.
2 (M. C. Z. 18366–7) Millaa Millaa, Q. (P. J. Darlington) 1932.
6 (M. C. Z. 18368–73) Vine Creek, Q. (P. J. Darlington) 1932.
1 (M. C. Z. 18374) Mt. Spurgeon, Q. (P. J. Darlington) 1932.

Millaa Millaa is on the Atherton Tableland, Vine Creek near Ravenshoe. The specimen from Mt. Spurgeon was taken between 3 and 5,000 feet. Fry's paratype came from a spot twenty-five miles inland from Cairns, so that our Kuranda frog is very nearly a topotype of *ornata*, and our Malanda specimen is actually a cotype of *reginae*, received from the Stockholm Museum.

[1] Parker, 1934, pp. 15-16 suggests Microhylidae in lieu of Brevicipitidae.

[2] This should be *Cophixalus ornatus fide* Parker, 1934, p. 173, who independently reached the same conclusion as to *reginae* being a synonym.

The series agrees well with this cotype, the striking color pattern is reasonably uniform and distinctive. If Andersson's figure 1c of plate i be compared with the figure in Fry's text all doubts as to the correctness of this synonymizing will be removed. Fry, however, was in error in referring *ornata* to his new genus Austrochaperina which is synonymous with Sphenophryne. As he had only two specimens it seems possible that he made no dissection. The structure of our frogs clearly shows their affinity with Phrynomantis.

The nearest relative of *ornata* is *Hylophorbus variegatus* van Kampen, 1923, of New Guinea. Direct comparison should be made between these frogs as the descriptions appear to agree except for some trifling details, chiefly of coloration. The largest specimen (No. 18374) measures 30 mm.

Sphenophryne gracilipes (Fry)

Austrochaperina gracilipes Fry, 1912, Rec. Austral. Mus. Sydney, **9**, p. 93, fig. 39, pl. viii, figs. 1, 1a, 1b; Somerset, Cape York, Queensland.

3 (M. C. Z. 18375–7) Rocky Scrub, McIlwraith Range, Q. (P. J. D.) 1932.

Rocky Scrub is about two hundred miles south of the type locality where the holotype was found. The species does not appear to have any very close ally in New Guinea.

The habit of two specimens is slender but that of the third is much more robust. When Fry states that the snout is "longer than the orbital diameter" it is obvious from his drawing that he means the snout as from the anterior border of the orbit, *not* from the nostril; tongue rounded and free behind (injured in the type); the tibio-tarsal articulation of the adpressed hind limb marks the eye in all three frogs as it did in the type. Gray above, a fine, hair-like, light, vertebral line from the scapula region to the anus was probably pink in life; otherwise coloration as in the type. The largest specimen (No. 18357) measures 17 mm.

Sphenophryne polysticta (v. Méhely)

Chaperina polysticta v. Méhely, 1901, Termész. Füzetek, **24**, p. 258, pl. x, fig. 3, pl. xii, fig. 4: Sattelberg, New Guinea.

Austrochaperina robusta Fry (part), 1912, Rec. Austral. Mus. Sydney, **9**, p. 89, figs. 35, 35a, 37, pl. ix (note other figs. are *brevipes*, fide Fry): Russell River, northeast Queensland.

Uperoleia marmorata Barbour (not of Gray), 1914, Proc. Biol. Soc. Washington, **27**, p. 202.

Austrochaperina brevipes Fry, 1915, Proc. Roy. Soc. Queensl., **27**, p. 61: Bloomfield River, near Cooktown, Queensland.

1 (M. C. Z. 7603) Kuranda, Q. (H. L. Clark) 1913.
1 (M. C. Z. 17806) Carrington, Q. (E. Mjöberg) 1913.
2 (M. C. Z. 18378–9) Millaa Millaa, Q. (P. J. Darlington) 1932.
3 (M. C. Z. 18380–2) Vine Creek, Q. (P. J. Darlington) 1932.
10 (M. C. Z. 18383–9) Mt. Spurgeon, Q. (P. J. Darlington) 1932.
5 (M. C. Z. 18501–5) Bellenden Ker Range, Q. (W. E. Schevill) 1932.
4 (M. C. Z. 19254–7) Kuranda, Q. (F. N. Blanchard) 1928.

All of these localities are within eighty miles of the type locality of *robusta* Fry, three of them within fifteen miles.

In structural characters the whole series agrees with *polysticta* of New Guinea, some are colored like the holotype of that species, others not. The series shows great variability in coloration though extremes are connected by intermediates; a constant feature appears to be a black ring encircling the anus. The type of *brevipes*, which was formerly a paratype of *robusta*, was subsequently separated by Fry on the grounds that it lacked the hair-like vertebral line which characterized his Russell River specimens. Andersson, who identified the Carrington frog as *robusta*, has commented (1916, p. 7) on this. One of his specimens (now M.C.Z. 17806), however, does show a trace of the hair-like line though indistinctly. I attach no importance to the presence or absence of vertebral stripes as in so many species they are known to be present or absent. Fry remarks that the coloration of his holotype of *brevipes* markedly resembles that of *polysticta* as revealed by Méhely's plate.

From *robusta*, Fry also separated *brevipes* on account of its stouter and shorter hind limbs and broader head. As to the first of these characters, I find in our Vine Creek, Mt. Spurgeon, and Bellenden Ker series that a variability of leg length occurs which embraces both *robusta* and *brevipes*; that is to say the tibio-tarsal articulation of the adpressed hind limb marks the axilla or tympanum, yet coloration and other characters make it evident that we are dealing with one series. The difference in the head dimensions—two-thirds in *brevipes*, five-sixths in *robusta*—probably may be accounted for by the difference in size, hence age, of the types. The type of *robusta* measured 28.5 mm., that of *brevipes* 23 mm., while our largest specimens (No. 18383, 18501, etc.) measure 27 mm.

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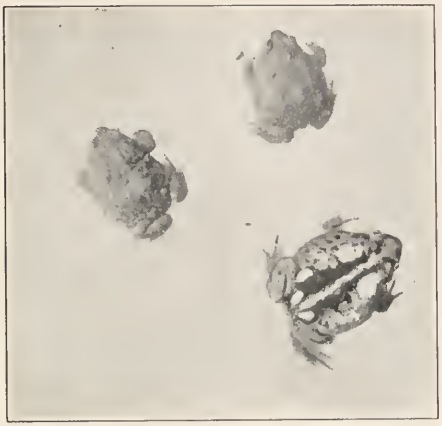
EXPLANATION OF PLATE

PLATE

Glauertia russelli Loveridge

Fig. 1. The type, R. 2608 in the Western Australian Museum.
Fig. 2. Lower surface of fore foot of type. Approximately × 10.
Fig. 3. Lower surface of hind foot of type. Approximately × 10.

The condition of the type being dry, these sketches by Mr. L. Glauert make the webbing appear less extensive than is actually the case.



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THE BUTTERFLIES OF CUBA

BY MARSTON BATES

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No. 2.—*The Butterflies of Cuba*

By Marston Bates

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21. *Erynnis zarucco*, venation 219
22. *Atalopedes mesogramma*, venation 223
23. *Prenes nero sylvicola*, venation 230
24. *Perichares coridon coridon*, venation 234

Introduction

This paper has been written with the object of providing a taxonomic analysis of the Cuban butterfly fauna, in the hope of thereby facilitating work on the many important problems connected with tropical insular biota. Studies of the Cuban fauna have been given a special significance by the establishment of the Atkins Institution of Harvard University at Central Soledad, with the resultant possibilities of coördinated and sustained observation. Because of this, the requirements of students who may be working in the Soledad laboratory have been kept in mind in preparing the keys and descriptions in this paper; much that will seem superfluous to a man working in a museum has been included, and many technical details, of interest only to the systematist, have been omitted.

At the same time, I have tried to remember the needs of lepidopterists and of general biologists interested in the problems of the origin and distribution of animal populations by including zoögeographical generalizations, as far as they seemed warranted by the material at hand. The basic units of classification have been given particular attention in this connection, as it is upon them that much of the entire structure of special biology must rest. I have tried to secure a sound and precise nomenclature with regard both to the definition of the general concepts involved, and to the applicability of the particular Latin formula used to designate any given population.

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Natural Sciences at my disposal. Mr. Tracy Hubbard kindly looked over the plant names used here, and suggested various changes that would bring the nomenclature into accord with current botanical usage. The field work in Cuba by Mr. Graham Fairchild and myself was made possible by a grant from the Atkins Foundation; our stay there was made pleasant by our many friends at Soledad.

Sources of material. The Cuban material in the Museum of Comparative Zoölogy (abbreviated in the distribution records as M.C.Z.), which forms the basis of this paper, comes largely from four collections. The first of these was made by Mr. Charles Wright, a naturalist who spent several years in the mountains near the Guantanamo basin, principally at the old cafetal "Buena Vista" in the Sierra de Yateras. He sent a great deal of insect material to the museum, including a splendid set of butterflies; they bear only the label "Cuba, Wright," but they seem in all cases to have come from the Guantanamo region, and they were probably mostly collected in 1859 or 1860. The second collection was made in the vicinity of Habana, in 1911 and 1912, by F. Cervera; it contains extensive series of the local species with good locality and seasonal data. The third collection, by far the largest in number of specimens, was made by Orazio Querci, who collected in Oriente for nearly a year in the joint employ of Capt. R. C. Williams and the late Mr. A. G. Weeks. Most of his material came from the Sierra Maestra, in the region about Santiago de Cuba. Williams (1931) has published a paper on the Hesperiidae collected by Querci at this time. The fourth collection was made by Mr. Graham Fairchild and myself during the summer of 1932 in the Cienfuegos region of Santa Clara, especially about the Harvard laboratory and gardens and in the nearby Trinidad Mountains. The locality "Soledad" in the distribution records indicates that the species has been found in the immediate vicinity of the Harvard station.

There are many specimens from other sources in the museum collection, including material taken by various students at Soledad or by members of the staff working in Cuba, and so forth. There is a particularly interesting set of Gundlach specimens, sent to Scudder and received by the museum with the rest of the Scudder collection.

The United States National Museum (U.S.N.M.) also has a great deal of Cuban material which I was able to study. Most of their specimens were collected in Oriente and Matanzas by Dr. Schaus, the indefatigable dean of American lepidopterists. The material in the Philadelphia Academy of Natural Sciences (A.N.S.P.) and in the

Fig. 1. Outline map of Cuba.

American Museum of Natural History (A.M.N.H.) was also examined, although in a very cursory manner. The Philadelphia Academy contains the very interesting material collected by Mr. C. T. Ramsden in Oriente, some of which is not duplicated elsewhere in American collections; they also have a very important old collection made by Poey.

Historical. Jacob Hübner, in his "Sammlung Exotischer Schmetterlinge," issued between 1806 and 1841, was the first to figure and describe Cuban butterflies. The few West Indian butterflies mentioned by Linnaeus or Fabricius were from Jamaica or the Lesser Antilles, but Hübner figured several distinctive Cuban forms in the first volume of his work. In the text of the "Zuträge" he credited the various Cuban species there described to one Herr Frank of "Havannah." Godart, in the "Encyclopédie Methodique" (1819), described a number of West Indian butterflies, but his material seems to have come almost entirely from Hispaniola and Puerto Rico.

We do not, then, find any work especially dedicated to our fauna until 1832, when the slim volume by Poey, the "Centuric," appeared. Twenty plates, each figuring a Cuban species and each accompanied by several pages of text, were issued between April and July of that year; the work was then interrupted by Poey's return to Habana, and never resumed. Poey continued to publish, however, until 1861, as will be seen by reference to the bibliography at the end of this paper. The most important of his papers were the "Catálogo" and the "Tériades cubanas." In the first, which appeared in short parts, all of the Cuban species known to him were listed, the undetermined ones simply as "two more species in this genus bring the total up to four," or some similar phrase. The second paper covers the Cuban species of *Eurema*, and is very well done, considering the difficulties under which the author must have labored. Gundlach quotes a saying of Poey that should be handed on: "Más vale ignorancia que error."

With this remark we come to Lucas, who prepared the part on the Lepidoptera in the "Histoire physique, politique et naturelle de l'ile de Cuba." This was an ambitious attempt to catalogue the Cuban species, rendered quite useless by the fact that the Cuban collections were hopelessly mixed up with the general collection of Lefebvre. The species listed as Cuban are usually from some part of the Antilles, but many are from North, Central or South America. I have thought it best to follow the precedent of Poey and Gundlach, and ignore species listed here unless the record has been confirmed by subsequent

collecting. I have only referred to the work in the case of species described as new, or when the reference is of particular interest for some other reason. All page references are to the French edition. The new species, which are often credited to Lefebvre, or even to de la Sagra, should be credited to Lucas.

Most of the butterflies collected by Gundlach were described by Dr. Herrich-Schäffer, of Regensburg. His several papers are listed in the bibliography.

Herrich-Schäffer described the species, but Gundlach did the work. We are concerned here only with Gundlach as a lepidopterist; but it must be remembered that his work on the Lepidoptera was but one aspect of a many-sided career. He is surely to be numbered among the few great naturalists who have worked in America. His volume on the Lepidoptera of Cuba is a marvel of accuracy, and I have availed myself freely of his material in the pages that follow. It is unfortunate that students of Lepidoptera have, in general, overlooked his work; it is rare, to be sure, but so are many of the volumes to which they constantly refer. Ramsden (1915b) has written a brief biography of Gundlach that should be read by anyone interested in Cuban entomology.

The post-Gundlach period is taken up mostly with scattered descriptions of new species, most of which have been discovered by Mr. C. T. Ramsden. Holland (1916) has published a list of the Lepidoptera of the Isle of Pines, covering 65 species of butterflies. Skinner described several new Hesperiidae from Cuba, and in 1924 published a very useful list of the Cuban skippers, in collaboration with Ramsden. More recently Williams (1931) has published an interesting paper on the Cuban Hesperiidae collected by Querci.

Nomenclatorial Units

The species problem. The basis of zoölogical nomenclature, since its inception, has been the species concept, and as two zoölogists rarely agree on a definition for species, considerable confusion has resulted. A geneticist (Goldschmidt, 1933, p. 540) may well remark: ". . . if we were to define the units which are meant if we are talking about the origin of species, the difficulties would be found insurmountable. In one taxonomic group, what is called a species is hardly distinguishable from the next species, and in another taxonomic group, the species are more different than genera in the first." If we read in a paper on zoögeography that a certain number of species are common to two

regions, the statement means nothing unless we are familiar with the ideas of its author about species, and with the general behavior of the group of animals about which he may be writing. This is, of course, true not only of species, but of all taxonomic units, and it has led to the very general conviction that all such units are merely subjective concepts of the taxonomic mind. This "species problem" has been ably surveyed by Robson (1928) in a recent book, and from his review at least one thing is very clear: taxonomy has by no means reached the stage where it is possible to generalize about "species" as a universal category of animals and plants.

But while a general definition of the word "species" may be impossible, that by no means precludes the possibility of giving it precise meaning for a given group of animals, and it seems to me that every biologist who uses the term is under obligations to define his usage. The definitions given here, then, are intended only to apply to butterflies, and to delimit the terms used in this paper. As the fundamental unit of classification I have used the concept of a homogeneous population limited in space, considering this to be capable of the most precise definition; this concept, usually called a *subspecies*, is here termed a *choromorph*.

Definitions. A *choromorph*, as the term is used in this paper, may be defined as a population with common (intermingled) ancestry, whose fusion with coexisting populations is prevented by some physiological barrier, and which is separated from similar populations in other areas only by physical (geographical) barriers, partial or complete, or by mere geographical distance, and which may be distinguished from such related populations by some heritable morphological characteristic.

The term *species*, as used here, applies to two sorts of things—monochoromorphic and polychoromorphic species. The general concept may be defined as a population or group of populations separated from other similar populations by some physiological barrier, which prevents fusion, and distinguishable by some heritable morphological characteristic. The polychoromorphic species may be defined more precisely in terms of the "Rassenkreis" of Rensch (1929, p. 11) as a complex of choromorphs which have developed directly from one another, have become geographically separated, and of which at least the neighboring forms are fertile *inter se*.

The term "choromorph." The category here defined as a choromorph obviously differs not at all from the subspecies of most mammalogists,

ornithologists and lepidopterists, so that a justification of this change in terminology is necessary. The significance of the subspecies is due to the widely accepted theory that geographical isolation is necessary for the formation of new species, and if the term is to have any meaning, it must be restricted to this usage for geographical varieties. Its use, then, implies that it is *only* through such varieties that new species may be formed.

The fallacy of this has been pointed out by Robson (1928, p. 117 *et seq.*), who maintains that there are many effective types of isolation besides the purely geographical, and probably many other types of subspecific variation of equal evolutionary significance. In the butterflies and in certain other well known animal groups geographical isolation seems to be the only factor at present in operation, but this by no means proves the general application of the theory, and it is possible that its importance in butterflies and land vertebrates is more apparent than real. It seems to me, then, that the term *subspecies* is really misleading and liable to cause confusion when its use, throughout zoölogy, is restricted to geographical varieties to the exclusion of all others. The logical definition of the term would be more general: it might well be applied to any partially independent population considered to represent an evolutionary stage in the development of species. In this sense, choromorphs would be one kind of a subspecies.

Since *race* is an English word with a large and varied accumulation of connotations from which it can hardly be separated, and since there are similar objections to the various other terms that have been used, it has seemed best to introduce the entirely new word, *choromorph*. Rules of priority do not apply to general terms, and if this word proves undesirable or useless, it will quickly be dropped from the literature. I am indebted to Prof. Wheeler for suggesting the word, which signifies "place-form;" *choros* is used in preference to *topos*, since it is already familiar in the form of *chorology*, and if the paleontologists feel the need of the analogue, they have the convenient term *chronomorph* ready formed for them.

Explanation of definitions. In the study of the classification of animals, it is obvious that the individual must form the starting point. Even the concept of the individual may become hazy in some colonial animals (siphonophores, sponges, *Volvox*); but in the case of butterflies we have no difficulty in distinguishing between this specimen and that specimen from the moment that the egg is laid until final death and decay. The clearest common bond between individuals is parentage,

and so we form the family concept of parent and offspring. Large groups of families, if followed for the course of a few generations, form into a complex tangle of parent-offspring and cousin relationships, so that it is no longer possible to tell where one family ends and another begins. Such a complex of inter-related individuals is known as a *population*, and it is on this concept that we would base the classification of animals.[1]

The inter-relations between populations may be of all sorts and degrees of complexity, but in the phylogenetic classification of animals we are concerned only with the genetic relationships. If we study the butterflies of a given place, it soon becomes obvious that they form a number of distinct populations, genetically completely independent of one another. The barriers that separate these populations are mostly of an unknown order, but they are probably to be found in the tropistic behavior surrounding mating. That such barriers exist we know from inference: the populations maintain their identity (do not fuse) and therefore they must be separated by some barrier, presumably physiological.

In actual practise, we recognize such populations by certain morphological peculiarities of color, pattern and form. There are possibly many distinct populations in nature that we do not recognize simply because they bear no external tag that we have discovered. For the purposes of taxonomy we must have some such tag, and hence our populations, to be recognized as species, must be distinguished by some morphological characteristic—and if the tag is to be reliable and universal in the population, it must be heritable.

The physical barrier of the sea separates Cuba from Hispaniola, so that the butterfly populations of the two islands are presumably independent except in the case of populations whose members can pass freely across the barrier. Again we find it impossible to distinguish these populations unless they are marked by some morphological characteristic. We may take, then, as an example of a choromorph, population A in Cuba, separated from population A′ in Hispaniola by the Windward Channel, and separated from the associated population B in Cuba by some physiological barrier—perhaps failure of the male of A to react to the smell of the female of B—and bearing a distinguishing tag by way of an extra spot on the forewing by which we can always recognize the individuals belonging to the population.

[1]It is impossible here to trace the very interesting history of the concept of species as populations; Kinsey (1930) has applied this system to the gall-wasp genus *Cynips*, and I am indebted to his paper for many ideas.

In continental areas the separation of associated populations A and B is on the same order; the separation of A and A′, however, may not be clearly defined by any such convenient gap as the Windward Channel. The change in appearance between specimens bearing the marks of A to those bearing the marks of A′ may be gradual, and it may be necessary to make an arbitrary boundary between the places where the specimens look most like A and where they look most like A′. But where constant differences have developed between specimens from two localities, there is generally at least a partial break somewhere between the two populations, otherwise the heritable morphological differences would hardly have developed to distinguish the two.[1] Phenotypic differences between specimens living in a moist region and those living in a dry region may show every sort of transition; but such differences do not make a choromorph, for they are not heritable. In general, it seems to me that the objections to choromorphs as taxonomic categories because of intergradation on continental areas arise either from inadequate material, from a failure to distinguish between possibly phenotypic and possibly genotypic variation, from a failure to correlate specimens and localities properly, or from a misunderstanding of the issue at stake.

The choromorph concept may thus be made fairly definite and objective. The species concept, as defined here, is admittedly largely subjective, although capable of objective test in theory. In the case of the continental choromorphs just discussed, it is fairly obvious that the existence of intermediate specimens in the border zone between A and A′ indicates that if free intercourse between the two populations were possible—if there were no physical barrier—the two populations would fuse. A and A′ are then clearly choromorphs of a single species, according to our definition. In the case of the island forms A and A′ on Cuba and Hispaniola, we have no such criterion, and we can judge only by analogy. If the differences are of the sort that usually separate independent but coexisting populations, we must call A and A′ distinct species; if the differences seem to be of a lesser order of magnitude, so that if the barrier separating Hispaniola and Cuba were removed, the two choromorphs would presumably fuse into a single form, we must consider them to represent but one species. It should be remembered that by definition two choromorphs of the same species cannot exist at the same place at the same time.

[1]Fisher (1930, p. 126) has proposed an interesting theory to account for the fission of a population spread over a continuous territory with gradual change in some environmental factor from one extreme of the territory to the other.

It is apparent, then, that I have stressed in these definitions the old criterion of interspecific fertility, although in a disguised form. Robson (1928, p. 77) has pointed out that all degrees of fertility exist between recognized taxonomic species, and that it is impossible to find a break in the chain between complete sterility and complete fecundity. It is undoubtedly true that associated populations vary in behavior in this respect; but it is also undoubtedly true that taxonomists vary in what they call species, and it is impossible to tell which sort of variation—that of the animals or that of the taxonomists—is covered by such a statement.

Nomenclature. The name formula of a butterfly used in this paper is composed of three elements—genus name, species name and choromorph name. This is in accordance with the widely accepted system of trinomial nomenclature now used in zoölogy: a system which, despite its clearness and simplicity, seems often to be misapplied by lepidopterists. For monochoromorphic species a binomial formula is used, as *Papilio devilliers*. A trinomial formula is always used in the case of polychoromorphic species in referring to any particular choromorph, as *Papilio aristodemus temenes*. The specific term is derived arbitrarily from that of the first described choromorph within the complex, and this first described form must always be designated by the complete formula, even though it involves tautology, as *Papilio aristodemus aristodemus*. The binomial, *Papilio aristodemus*, then applies to the choromorph complex as a whole.

No other classes of names are recognized in this paper. It seems to me that the Linnean nomenclature, if it is not to become hopelessly unwieldy, is best restricted to the classification of populations. The classification of individuals within the population—of seasonal forms, aberrations, dimorphic female forms, and the like—is essentially a separate problem.

Significance of units in evolution. In a recent article, Goldschmidt (1933, p. 542) states that "The changes necessary for the formation of a new species are so large that the relatively small differences of the subspecies as a starting point would hardly count. And I cannot help confessing that after trying to get acquainted with the taxonomist's material, the skeptical standpoint derived from my own genetic analysis could not be shaken. There is in my opinion no reliable fact known which would force us to assume that geographic variation or formation of subspecies has anything to do with speciation; the results of genetical

analysis and of sober evaluation of the other facts are positively in contradiction to such an assumption."

The taxonomic system that I have used here is based entirely on the theory that choromorphs (geographical subspecies) are the basic unit in the evolutionary series in butterflies—the starting point of population divergence. It is, then, impossible to ignore the challenge offered by Goldschmidt entirely, although at the same time it must be admitted that the data available are not of the sort that would be convincing to a geneticist; nor is this the place for a complete overhauling of the questions involved. Goldschmidt's analysis of the geographical forms of the moth, *Lymantria dispar* (Goldschmidt, Seiler & Poppelbaum, 1924), is unquestionably the most thorough study so far made of such variation in a particular species; but at the same time it seems to me of little significance as far as the general problem is concerned. The "races" of *Lymantria* occupy areas with diverse environments, and most of the racial characters that he stresses are in some way concerned with adaptations to these environmental differences. Now the vast majority of the choromorph characters used in butterflies are in no sense adaptive, and it does not seem likely that they are correlated with other, unknown, characters of adaptive significance. The genetics of geographical variation in areas of apparently identical environment must be investigated before the careful arguments elaborated by Karl Jordan (1905) can be broken down.

There are many cases of purely phenotypic changes in animal populations corresponding to changes in environment over the range of the species. No such case is known in the West Indian butterflies, and it is unlikely that such exist, as the environments of the different islands, when we consider each island as a whole, do not appreciably differ in elements that would affect the life history of a butterfly. As an example, however, we may take the North American butterfly, *Papilio glaucus*. Clark (1932, p. 184) maintains that the form described as *Papilio glaucus canadensis*, which occurs over the northern part of the species range where there is but one generation a year, corresponds to the spring form of the species in more southern localities, as in the District of Columbia. If this is true, and if the characters of the Canadian form and of the southern spring form are phenotypic, the result of temperature, then *canadensis* might be called a *pseudochoromorph*. Any arguments based on a study of this sort of a form have no force when applied to any of the West Indian cases described in this paper.

The case of *Lymantria dispar*, worked out by Goldschmidt, is

admittedly different from either that of *P. glaucus* or of any of the West Indian choromorphs, insofar as his researches show that the racial differences in *Lymantria* are genotypic, but very likely produced by a sorting out of preadaptations into the proper environmental niches. This sort of phenomenon is probably fairly common, but it can hardly be held to apply to the differences that characterize populations on Cuba, Hispaniola and Jamaica.

Goldschmidt states that "the changes necessary for the formation of new species are so large that the relatively small differences of the subspecies as a starting point would hardly count." I cannot understand this assertion, unless it is based only on his experience with the species of *Lymantria*. We find everywhere in the butterflies complete gradation between populations that are unquestionably merely *choromorphs*, and populations that are unquestionably independent and coexisting *species*; and the line between the two, as drawn in our definitions, is admittedly arbitrary and subjective in practise. Hence I have considered that the choromorph, not the species, must be used as the basic unit for study and comparison. For instance:

1. *Heliconius charithonia charithonia*. The width of the yellow bands in Cuban specimens is fairly constant; in many Hispaniolan specimens the bands are narrower. The range of variation in the two populations is somewhat different, but they are not distinguished by any fairly constant character, and so they are considered to belong to the same choromorph. Specimens from Jamaica have the bands constantly wider than those from other populations, so that a Jamaican specimen can always be recognized, although the differences are slight, and entirely superficial as far as I have been able to determine. The Jamaican population is considered to form a distinct choromorph. *H. charithonia simulator*.

2. *Colaenis julia nudeola* from Cuba has, in the male sex, two spots at the end of the cell in about 90% of the specimens; in the others there is only one such spot. The spots were not confluent in any of the specimens studied. In *C. j. haitensis* from Hispaniola, these spots merge to form a band. Specimens from Jamaica (*C. j. delila*) are almost immaculate above, with at most only a vague indication of one of the spots at the end of the cell. I have not been able to find any structural differences (genitalia) between any of these forms; in no case, however, does the range of variation in pattern in one population overlap that in another, and the three are considered to be distinct choromorphs. Similar forms of this species on the continent are much less sharply defined.

3. *Athena cleuchea cleuchea* from Cuba has, in the male sex, a well developed postdiscal line on the forewing, which is greatly reduced or absent in *A. c. pellenis* from Hispaniola; there are other slight differences in pattern, but none very noticeable. If we examine the male genitalia, we find that the outline of the clasper is different in the two choromorphs, and that there are various differences in proportion in other parts of these organs.

4. *Anartia lytrea chrysopelea* from Cuba is quite distinct from *A. l. lytrea* from Hispaniola in almost every way; yet the differences are all of degree—lighter ground color, reduced markings, larger size, and so forth. The two were early described as "species;" yet here they are listed as choromorphs of the same species, largely because the structural differences (in the genitalia) are slight, and concerned with proportion only, and because the two forms are obviously close in all respects, and together quite distinct from any of the other species of the genus. They might, however, almost equally well be regarded as "species;" only by bringing the two forms together in the laboratory for experimental breeding could their status be settled with any certainty.

5. The case of *Lucinia sida* and *L. cadma* is almost exactly like that of *Anartia lytrea*, but these two forms are somewhat more distinct structurally, and they have been given "specific rank" in this paper.

6. From this we pass to examples like the West Indian forms of *Dismorphia*, *Hymenitis* and *Calisto*, where each island is inhabited by a distinct form, comparable in all respects to the ordinary species of taxonomists. In some cases, where closely related species inhabit the same area, as *Papilio pelaus atkinsi* and *Papilio oxynius*, or *Papilio cresphontes* and *Papilio thoas oviedo* in Cuba, we may conjecture that the original distribution of choromorphs has become disturbed, and the extreme forms have come again to live side by side, each sufficiently distinct to maintain its identity as a separate population.

7. One of the most interesting cases of this sort is furnished by the American forms of *Precis*. Cuba is inhabited by two forms that are apparently quite independent—"good species." The one form is like that found in the United States (*P. coenia*); the other is found in Cuba, Hispaniola, Jamaica and northern South America (*P. zonalis*). The two are apparently connected by intermediate forms in Central America. The material available has proved inadequate for a thorough study of this group, as the range of individual and seasonal variation is large, but it is difficult to avoid the inference that extreme forms have become differentiated on the continent and have reached Cuba from

the north and from the south, sufficiently distinct to maintain their identity there as separate populations.

Where is the break in this chain between the "relatively small differences between subspecies" and the "large changes necessary for the formation of new species?"

In a way, island choromorphs are probably not particularly suited to the study of problems related to evolution, since it seems likely that most of the significant development of species takes place on continental areas. It is well known that island faunas are apt to be conservative, perhaps because once isolation has taken place, there is little chance for the isolated populations to come again into contact, with a consequent multiplication of the number of coexisting species.

Again, we know nothing at all of the drive behind evolutionary change. Perhaps this drive is not as powerful in small isolated island communities as it is on continental areas, where the "struggle for existence," the "survival of the fittest" and so forth may be more effective. It is certain, from the geological evidence, that some species have remained unchanged, at least as far as perceptible characters are concerned, for long periods of time, while others have undergone considerable modification. The explanation of this, however, need not involve directly the concept of the choromorph. It seems to me very clear that geographical isolation *permits*, but by no means *causes* the development of new forms. Taxonomists and paleontologists have for the most part become thoroughly permeated with Lamarkian ideas, so that it is no wonder that the geneticists are apt to regard all taxonomy as "queer." Goldschmidt starts the article to which I referred above (1933, p. 540) with a quotation from Osborn which thoroughly mixes some kind of a mystical orthogenesis with the concept of subspeciation, and both Goldschmidt and Osborn seem to have considered the mysticism and the subspeciation to be inextricably united. If we are ever to reach the stage where it is possible to discover the underlying principles of animal evolution, we shall each have to learn how to sort out the facts from the speculations in the work of our colleagues. And while it is undoubtedly true that the taxonomist has a very great deal to learn from the geneticist, it is also true that the geneticist will probably find much of interest and of use to him in the accumulated experience of those who have for so long been patiently pigeon-holing all the different "kinds" of animals they can find.

References. I have attempted here only to justify the nomenclatorial system that has been used in this paper. The literature on geographical

variation is becoming enormous, and it has been ably reviewed by several recent authors. The most thorough summaries of the evidence offered by Lepidoptera will be found in Rothschild and Jordan (1903, pp. xxvi–xliv) and in the article by Karl Jordan (1905). The paper by David Starr Jordan (1905) is interesting because of the wide currency of "Jordan's Law" to the effect that related species occur always in neighboring but distinct regions; the application of the law, of course, depends on the definition of species. The recent books by Kleinschmidt (1926) and Rensch (1929) contain interesting reviews of the evidence from a wide variety of sources; Rensch includes a useful bibliography, as does Robson (1928). Pearse (1934) has published a suggestive review of factors related to ecological segregation, which reminds us again that isolation, to be effective, need not always be geographical.

Geography

The American land mass, from the geographical point of view, can be conveniently considered as composed of three major areas, North, Middle and South America. The Middle American region is in many respects a more or less indefinite transition zone, including the heterogeneous elements of Mexico, Central America, Panama and the Antilles. These political units, with slight alterations, serve very well for biological purposes. Mexico is distinct largely because of its amazing mixture of tropical and temperate climate and biota. If we add Chiapas and the neighboring areas to the political Central America (Guatemala, Salvador, Honduras, Nicaragua, Costa Rica), and if we ignore the temperate elements found on the Guatemalan plateau, we have a fairly definite faunal area, merging with the Sonoran in Mexico and with the more typical South American in Panama. The Antilles sprawl out between these continental divisions, overlapping Florida on the north, separated from Yucatan on the west by about 200 kilometers, and reaching to within 125 kilometers of South American faunal areas (Grenada to Tobago and Trinidad) in the south.

The Antillean archipelago comprises an amazing number of islands, islets, rocks and reefs, logically divisible into three groups—the Bahamas, the Greater Antilles and the Lesser Antilles. We are here concerned almost entirely with the Greater Antilles, including Puerto Rico (area about 8,900 sq. km., maximum elevation about 1,100 meters), Jamaica (area 11,500 sq. km., max. elev. 2,200 m.), Hispaniola, composed of the two republics of Haiti and Santo Domingo (area, 76,500 sq. km., max. elev. 3,200 m.) and Cuba, which we shall con-

sider in greater detail. Perhaps the best geographical account of the West Indian region as a whole known to me is that of Hill (1898); the various accounts in Shelford (1926) will also be found to be useful, but most of the recent guide books and so forth prove disappointing to the biologist.

Cuba is the largest of the Antilles, with a total area of about 112,000 square kilometers, a total length of about 1200 km., and a breadth that varies between about 40 and 200 km. It is about 210 km. from the nearest point in Yucatan, about 150 km. from Key West, Florida, some 77 km. from Hispaniola, about 80 km. from the nearest of the Bahamas (Great Inagua) and some 160 km. from Jamaica. It is just south of the Tropic of Cancer, and extends roughly between 19° 48′ and 23° 3′ North Latitude and between 74° 7′ and 84° 57′ West Longitude. The topography is varied, including almost all of the possible tropical habitat types except the extreme xerophytic; the greatest altitude is probably that of Pico Turquino, 1,950 meters.

The distribution of the various butterfly species in Cuba has been summarized by provinces, as the material available does not warrant any finer analysis. The general plan of the six Cuban provinces is indicated on the accompanying outline map (figure 1). Pinar del Rio, the westernmost province, has an area of 12,991 sq. km.; it includes the *Cordillera de Guaniguanico*, or the Organos Mountains, which reach a maximum elevation of 760 meters. This is the least known part of Cuba, as far as the butterflies are concerned, and it will probably yield several additional species.

The next province is that of Habana. The Isle of Pines is politically a part of Habana, but it has been kept separate, for obvious reasons, in summarizing distribution. The area of Habana province is 10,425 sq. km., of which 2,126 sq. km. go to make up the Isle of Pines, and 105 sq. km. various outlying *cayos*. No butterfly collecting seems to have been done on any of these Cuban *cayos*, so they have been left entirely out of consideration in the preparation of this paper. Habana province includes several ranges of low hills, but no distinctive mountain areas. Several butterfly species, however, are known only from this section (*Papilio polyxenes, Zerene cesonia*).

Matanzas (8,479 sq. km.) is very similar to Habana.

Santa Clara (20,911 sq. km.) includes the Trinidad Mountains and the Zapata swamp as topographic features of particular biological interest. The Trinidad Mountains reach a maximum elevation of about 950 meters, and various butterflies that occur there are found elsewhere only in the mountains of Pinar del Rio and Oriente. Curi-

ously some of the species found both in Pinar del Rio and Oriente (*Hymenitis*, *Dismorphia*) have not yet been found in these central mountains. Apparently no butterflies have been collected in the Zapata swamp since the days of Gundlach; several peculiar birds are found there, but it would not be so apt to have distinctive butterflies.

Camagüey (24,145 sq. km.) is mostly a great plain, given over to sugar cultivation. Little collecting has been done there and there is no reason to expect any peculiar forms.

Oriente (34,878 sq. km.) is the largest of the provinces, the most varied, with the Sierra Maestra reaching a maximum elevation of about 2,000 meters, and the richest zoölogically. Many species are known only from this part of Cuba, and some of these (*Papilio gundlachianus*) seem to be relict forms, not closely related to any other known butterflies. The region is fairly well known because of the activity of various collectors at Santiago de Cuba and Guantanamo, and because visiting entomologists have usually spent a good part of their time there.

Those desiring a more detailed account of the local geography will do well to consult the text used in the Cuban schools (Aguayo and de la Torre, 1928). The physical features of the island, as far as they are related to the fauna, are admirably treated by Barbour (1923) in the introduction to his "Birds of Cuba;" and Brother Leon has written a brief ecological account of the island in Shelford (1926, pp. 682–694).

Geology

The accounts of the geological history of the Antilles given by various authors are exceedingly diverse and often flatly contradictory, so that it is difficult to piece together a coherent or authoritative account. It is especially difficult to sort out statements in the literature based on geological evidence from those based on recent zoögeographic evidence. The paleogeographer makes a land bridge because he thinks the present animal distribution requires it, and we then take the land bridge as a geological construction, trying to explain the present fauna on that basis—no progress can be made by such circular methods. The Antilles seem indeed to have been a happy hunting ground for the land bridge architects, and one of the best known of these, Guppy (1909, p. 391), can casually make a statement like this: "It is, I think, pretty clearly made out that there was in tertiary times a land connexion between the Caribean and North Africa. . . ." There seems to be little middle ground between this sort of thing, and the papers of the more

prosaic geologists, who go about their business of making stratigraphic descriptions of the region, without any mention of the possible presence or absence of this or that land connection.

It is fortunate that butterflies have wings, and can often fly for considerable distances, at least with favorable winds, so that we are by no means dependent on land bridge constructions. It is difficult to deny the zoölogical evidence for former continental connection with Cuba; yet if there has been any such connection recently, it seems quite impossible to explain the present poverty of the fauna, and the complete absence of many important groups. Students interested in pursuing this question further will do well to consult the well known paper by Matthew (1915) and Barbour's review (1916). It seems to me that the Miocene submergence of Cuba (Lewis, 1932) offers an excellent way out of the land-bridge dilemma. One can have all the connections needed in pre-Miocene times, and then have any excess population killed off in Miocene, with enough things surviving on the mountain tops to repopulate the country.

Barbour (1923, pp. 9–13) has reviewed the early work of Hill, Vaughan and others on the geology of the region, summarizing the results in a table. Recent work on index fossils in the various Cuban formations has somewhat altered the sequence given there; a paper by Lewis (1932) summarizes the present geological information, and includes a bibliography of recent special papers. Schuchert (1929) has written a very interesting summary of the geological history of the Antillean region, with many maps; but it is unfortunately impossible to sort out the geological from the zoögeographical evidence in his paper.

We are here interested only in the events of Tertiary times, as modern butterfly types are probably not much older than that.[1] Schuchert (1929), states that "apparently all of the Greater Antilles with the exception of western Jamaica were emergent during early Eocene time . . . in Upper Eocene the Greater Antilles were more or less inundated." On his map (fig. 6, *l.c.*), he shows a Honduras-Cuba land connection for Upper Eocene. Lewis (1932, p. 541) mentions several Eocene formations in Cuba.

Barbour and Schuchert both consider the Oligocene to have been a period of widespread submergence in the Antillean region; this supposition, however, seems to be based largely on the Yumeri and similar limestones which, on the basis of foraminifera determinations, are now dated from the Miocene. Thus one may perhaps assume that the Oligocene submergence was not as extensive as has been hitherto

[1]Forbes (1932) has given an account of the possible age of the Lepidoptera.

supposed. Lewis (1932, p. 541) states that "overlying the Eocene in several localities are limestones which are very similar to the members just described [Eocene], but which contain foraminifers that are diagnostic of the Oligocene. These can be differentiated only by the most painstaking micropaleontology."

The Miocene, according to the older accounts, was a period of emergence. Lewis, however, (1932, p. 550) states that "during the Miocene the entire island, with the exception of the Organos Mountains, the Trinidad Mountains, the Sierra Nipe, the Sierra Maestra, and a few isolated peaks along the axis of the island, was submerged and reef limestone, marls, and limestone conglomerate, reaching, in some places, a thickness of 1,700 feet, were deposited, overlapping the slightly folded and eroded older formations."

The island is presumed to have emerged approximately to its present position at about the end of the Miocene, and during the Pliocene and Pleistocene to have undergone only minor oscillations, of little interest to us here. It is noteworthy, however, that Lewis dates the mountains of Oriente from Pleistocene, stating that they appear to be among the youngest and best defined fault-block mountains of the world. "In fact, many of the fault scarps in this region are of such recent origin that no appreciable talus has formed."

The Antillean Butterfly Fauna

Kaye (1926 and 1931) has published a list of the butterflies of Jamaica, where he found 106 species. Hall (1925) has written a similar list for Hispaniola, enumerating 139 species; while the last published list for Puerto Rico (Wolcott, 1924) lists 106 species. If we add these lists to the present enumeration of the Cuban butterflies, we get a fair picture of the Antillean fauna. The Jamaican, Cuban and Puerto Rican lists are probably about equally complete; only the Hispaniolan fauna is comparatively inadequately known.

Poverty of fauna. It appears at once that the West Indian butterfly fauna is very limited. We should expect two or three times this number of species in large and varied tropical islands. Kaye (1904) listed 289 species from the small island of Trinidad (about 5,000 sq. km. in area), a list that is by no means complete; and we should find two or three times the number of species known from Cuba in an area of comparable size and diversity on the Central American mainland.[1]

[1]Godman and Salvin, in the Biologia Centrali-Americana, list 1805 species of butterflies from Central America.

It is very difficult to get accurate data for faunal comparisons in insects, but this poverty of species seems to hold true for other groups in the West Indies, with some striking exceptions—the Cuban Sphingid fauna, for instance, is well developed, with some 60 species represented

Antillean Fauna

		Cuba	Hispaniola	Jamaica	Central Am.	South Am.	North Am.			Cuba	Hispaniola	Jamaica	Central Am.	South Am.	North Am.
1.	Pieris	x	x	x	x	x	x	24.	Vanessa	x	x	x	x	x	x
2.	Appias	x	x	x	x	x		25.	Hypanartia	x	x	x	x	x	
3.	Melete	x	x		x	x		26.	Precis	x	x	x	x	x	x
4.	Eurema	x	x	x	x	x	x	27.	Anartia	x	x	x	x	x	
5.	Phoebis	x	x	x	x	x	x	28.	Metamorpha	x	x	x	x	x	
6.	Anteos	x	x	x	x	x		29.	Athena	x	x	x	x	x	
7.	Kricogonia	x	x	x	x			30.	Hypolimnas	x	?	x		x	
8.	Zerene	x	x	x	x	x	x	31.	Historis	x	x	x	x	x	
9.	Nathalis	x	x	x	x	x	x	32.	Coea	x	x	x	x	x	
10.	Dismorphia	x	x		x	x		33.	Colobura	x	x	x	x	x	
11.	Danaus	x	x	x	x	x	x	34.	Lucinia	x	x	x			
12.	Lycorea	x	x		x	x		35.	Eunica	x	x	x	x	x	
13.	Anelia	x	x	x	x			36.	Dynamine	x	x	x	x	x	
14.	Hymenitis	x	x	x	x	x		37.	Cystineura		x	x	x	x	
15.	Calisto	x	x	x				38.	Didonis		x		x	x	
16.	Heliconius	x	x	x	x	x		39.	Ageronia		x	x	x	x	
17.	Eueides	x	x		x	x		40.	Myscelia		x		x	x	
18.	Metamandana		x		x	x		41.	Adelpha	x	x	x	x	x	
19.	Colaenis	x	x	x	x	x		42.	Doxocopa	x	x	x	x	x	
20.	Dione	x	x	x	x	x	x	43.	Asterocampa	x			x		x
21.	Euptoieta	x	x	x	x	x	x	44.	Prepona	x	x		x	x	
22.	Phyciodes	x	x	x	x	x	x	45.	Siderone	x	x		x	x	
23.	Chlosyne	x	?	x	x	x		46.	Anaea	x	x	x	x	x	x

Distribution of Antillean Genera of Pieridae, Danaidae, Nymphalidae

there. It is interesting to note that the mollusc fauna of Cuba is very rich; but Mr. Clench tells me that this fauna may have arisen locally from a comparatively few types.

Distribution of genera. The accompanying table shows the distribution of the genera of butterflies in the Greater Antilles. The Hesperiidae have been omitted, as it is difficult to correlate the generic

names under which the species from different islands have been listed; their distribution seems to be similar to that shown by the other families, however; there are no peculiar Antillean genera. The Papilionidae and Lycaenidae have also been omitted, since the genera in these families are purely artificial groups, their distribution of no significance.

In the first place, it appears that almost all of the genera are widespread, and that only two (*Calisto* and *Lucinia*) are confined to the West Indies. Of the 46 genera listed, only 13 extend into the United States north of Florida; and of these 13, all except one are also found in South America. The exception (*Asterocampa*) is a rather doubtful Nearctic genus that should probably be united with the Old World *Apatura*. The affinities of the fauna, then, are unquestionably Neotropical. It is curious that no South American genus not also found in Central America is represented, although the reverse is not true. Some of the individual species, however, are closer to South American than to Central American forms.[1]

Of the two genera known only from the Antilles, *Lucinia* is very close in structure to the widespread Neotropical *Eunica*, while *Calisto* forms a markedly distinct Antillean group, which Forbes (1930, p. 9) considers to be most closely related to certain Chilean forms. *Lucinia* is represented by forms on each of the islands sufficiently similar in appearance and structure to be possibly considered as merely choromorphs of a single species. *Calisto*, on the other hand, includes one species from the Bahamas and Cuba, three from Hispaniola, one from Puerto Rico and one from Jamaica. The species are quite distinct in appearance, and extraordinarily so in structure. Genitalia slides were made of most of the forms, in the hope of showing the interspecific relationships, and these organs were found to be as diverse in the different species as is usually the case with genera. From this it would appear that the group may be a very ancient one, the species long isolated and stable.

Absence of certain groups. If we compare this list of West Indian genera with a similar list from any other part of tropical America, we notice a number of striking omissions. There is only one Ithomiid genus, *Hymenitis*, with only one form on each island; there is only one Satyrid genus, *Calisto*; there are no Morphids, no Brassolids, and

[1]An apparent exception to many of these statements, *Hypolimnas*, is an African genus of which only a few American specimens are known, so that no significance can be attached to its distribution. It is generally supposed to have been introduced at the time of the slave trade.

only one little known Riodinid. Yet all of these are large and well developed groups everywhere else in tropical America. In the moths, one other case may well be considered at the same time: the region, although rich in Sphingids, has not a single Saturniid.[1]

This situation has been commented on by almost everyone who has written on the distribution of West Indian insects, but usually no explanation is attempted (see Forbes, 1930, p. 8; Kaye, 1926, p. 455). To me, all of the evidence points plainly to the Antillean fauna's consisting of a nucleus of very old types supplemented by many recent (post-Miocene ?) adventitious arrivals. It may be worthwhile to examine this hypothesis in some detail.

The groups that are absent or scarcely represented in the fauna—Ithomiids, Satyrids, Morphids, Brassolids, Riodinids, Saturniids—are all weak or local flyers. At first glance this statement seems obviously false. Kaye (1926, p. 456) states definitely: "Feeble flight alone cannot account for the absence of these forms, as in spite of the hurricanes weak-flying *Terias* [*Eurema*] are to be found commonly." Forbes (1930, p. 8) says of the Saturniidae, "they are strong flyers." No one who has sadly watched a *Morpho* sail out of reach would deny the marvelous ability of that genus in flying, and the Castniids, also absent from these islands, are among the most violent of all Lepidoptera on the wing. On the other hand the *Eurema*s which, as Kaye points are abundant on all of the islands, flop about over the grass in a very lackadaisical manner. To lump all of the missing groups as weak or local flyers and all groups present as strong flyers, seems at first certainly nonsense.

Yet, if we examine the picture carefully for details, it changes somewhat. No one will deny that the Ithomiids are weak flyers, usually confined to the shade of the deep forests. The Satyrids are also feeble flyers, although some species are capable of astonishing spurts of speed when chased. The *Morphos* are large, broad-winged butterflies that soar easily through the forest, tireless and powerful. But they are essentially forest insects, probably never straying far, and very unlikely to go wandering out to sea. Many of the forms are quite local, in strong contrast to the wide dispersal of apparently weaker flyers like *Vanessa* and *Euptoieta*. Furthermore, the *Morphos* are essentially South American insects, with comparatively few forms in Central America,

[1]A Hemileucid moth described by Walker as *Lasiocampa plana* has recently been rediscovered in the high mountains of Haiti; it has not yet been critically studied.

so that it is possible that the Antillean environment is not suited to them.

The Brassolids are again large and apparently powerful insects, and unlike the *Morphos*, they are common in Central America. Their food-plants—palms and the like—are abundant in the West Indies. But again, the Brassolids are local, forest loving butterflies. The *Caligos* in particular are very sedentary, and while the *Opsiphanes* species are exceedingly vigorous, their flights seem to be local. No Brassolids are known to migrate.[1]

The Riodinids are, like the Satyrids, generally admitted to be weak flyers. The species are, as a rule, even more local than the Satyrid forms. None is known to migrate.

The Saturniids, while not "butterflies," should be considered here, as they are the group that Forbes seems to have thought to wreck the feeble and local flying theory. I do not see this at all. They are large insects, to be sure, and it is known that males will fly considerable distances to reach a female, battering vigorously against a cage in which a female is confined. But such an incentive is lacking in the case of a sea voyage to Cuba. The females of Saturniidae have atrophied mouth parts, take no food as adults, and die within a few days. They are heavy bodied and apt to be sedentary. None of the insects usually reported on shipboard 200 miles at sea belongs to this family.

Forbes emphasizes the fact that the family is well developed in tropical America. He says: "They are an ancient group which must have existed in South America for an enormous length of time, as a whole group of primitive genera (*Automeris, Dirphia,* etc.) are dominant there. Also South America contains the annectant Oxytenidae and Cercophanidae, suggesting that the whole family may have arisen in that continent." Unfortunately, I am in no way prepared to discuss primitive versus specialized groups in the Lepidoptera; but accepting these statements as facts, it seems to me quite possible that not very long ago—say at the beginning of Cenozoic time—there were not any Saturniids in South America. In fact, the abundance of primitive forms there might equally well be used as an argument for the comparatively recent arrival of the group. When we remember the great shifts in

[1]The data on migration used here are taken from C. B. Williams (1930). The presence of an occasional specimen of one species in a migrating horde of another species is no proof of wandering habits, as from my own observations I believe that almost any butterfly is liable to join a migration for a short distance, then drop out. The behavior of these hangers-on would make a very interesting study.

distribution known to have occurred in mammals, we become skeptical about any evidence that seems to keep insect groups in place for any great length of geological time. There are, in fact, a number of points about the distribution of Saturniid genera—sometimes utilized by intercontinental land-bridge architects—that would make an interesting study from the point of view developed by Matthew (1915), but such speculations are completely foreign to our present topic. I think it is clear, first, that the Saturniidae are not powerful flyers, in the sense that the Sphingidae are, and second, that arguments based on the present distribution of primitive genera must be viewed with caution.

The other side of the question remains to be examined—the presence of so-called weak flyers on the Antilles. Kaye (1926) seems to stress the great development of *Eurema*. While a *Eurema* flying about the grass seems as feeble as any Satyrid, we have the evidence to the contrary offered by its well known habit of migrating. C. B. Williams (1930, p. 131) refers to various instances of great swarms of *E. lisa* appearing off Bermuda. Surely this is not a sign of weak flight! The skippers, well represented in the West Indies, might seem to have the same sort of flight as many Riodinids. Many skippers are wide ranging, however, some species extending from Canada to the Argentine with no apparent variation; various instances of migration of species in the group are known. *Calisto* and some other weak-flying genera may be comparatively ancient inhabitants of the region, left over from a time when access was easier.

I am well aware that there are many exceptions to the arguments that I have given above, but these exceptions seem to me of comparatively little weight when compared with the striking general occurrence of wide ranging, strong flying butterfly groups in the West Indies, and the absence of butterflies belonging to groups characterized by weak flying, non-migrating and local habit. It might be well to point out some of the exceptions—the occurrence of *Apodemia carteri*, a Riodinid, in the Bahamas and Cuba; the presence of *Rothschildia*, a Saturniid genus, on Martinique; the presence on all islands of Syntomidae, a family apparently as local and weak in flight as the Riodinidae, and so forth. It would obviously require some straining of the imagination to explain away each and every exception of this sort, and it seems to me unnecessary even to try. We do not know enough about the habits of the various species involved to consider individual cases in any detail. Perhaps we do not know enough about the general habits of butterflies even to postulate as much about the different groups as

I have done. The subject is a very interesting one, however, and surely worthy of more detailed consideration than it has been possible to give it here.

Homogeneity of fauna. That the fauna is homogeneous is indicated on our generic table, which shows that thirty-four of the forty-six genera there listed are found on all three islands. Of the twelve not so distributed, seven are found in Cuba and Hispaniola, but not in Jamaica; two are found in Hispaniola and Jamaica but not in Cuba, while three are limited to Hispaniola. None is limited to Cuba or to Jamaica.

The seven genera found in Cuba and Hispaniola but not Jamaica are all very large, very widespread Neotropical genera, in each case represented by only one species on each island, although in two cases the Hispaniolan and Cuban forms may be called distinct species, in three cases distinct choromorphs, and in the remaining cases the Antillean choromorph is distinct from any continental form. In short, in none of these seven cases is the Antillean form identical with the continental form. That would seem to indicate that the island populations were at the present time effectively isolated from their continental relatives, and that the original colonization either dated from the time when the islands had continental connections, or were accidents of the sort not easily nor often repeated. The two genera limited to Jamaica and Hispaniola are also widespread in tropical America, and in one case (*Cystineura*) the two island forms are remarkable and distinct species. In the other case (*Ageronia*), three species are reputedly found in Hispaniola, one of which occurs also in Jamaica. There is a long series of Haitian specimens in the American Museum of Natural History, and Mr. Watson tells me that these all represent one form, and that he thinks the other two names are errors of determination. In that case, the Jamaican and Hispaniolan forms are supposedly identical, but different from the continental choromorphs. The distinctness of the *Cystineura* species may indicate that they, like *Calisto*, were left over from pre-Miocene days, and that there is a form yet to be discovered in Cuba, or that the Cuban form has died out.

The Bahamas and the Lesser Antilles have not been included in this discussion, because exact information on the presence or absence of this or that form from a particular island is lacking. In general, however, these islands show the same faunal type as the Greater Antilles; their faunas are somewhat more depauperate, perhaps, but that may be explained by the smaller areas. Butterflies from all parts of the

Antilles belong to the same genera, often to the same species, and in many cases to the same choromorphs. This may indicate a common origin for the fauna, it may be the result of the selective action of a uniform and common environment, or it may simply mean that a butterfly that can get to one of the islands can, in time, get to all of them.

Inter-island relationships. One of the most remarkable things about our table of genera, it seems to me, is that every genus there listed occurs in Hispaniola. The significance of this is even greater when we remember that Hispaniola is the least known of the three islands; the two genera that are questioned in the table quite certainly occur there, as they have been found in Puerto Rico.

Hispaniola, then, is the focus of Antillean distribution. We have only four combinations on our table: Hispaniola, Cuba and Jamaica; Hispaniola and Cuba; Hispaniola and Jamaica; and Hispaniola only. The three other possibilities—Cuba and Jamaica, Cuba only, and Jamaica only—do not occur. If we examine the distribution of species, bearing in mind the fact that Hispaniola is comparatively unknown, we find further evidence for the belief that animal distribution in the West Indies is not haphazard. Barbour (1910, p. 277), speaking of reptiles, has remarked: "A peculiarity of the fauna of Jamaica is the fact that while its proximity to Cuba is practically the same as its distance from Haiti, the evident relationship of the island's fauna with that of Haiti is well marked, while with Cuba it has in common only species which range widely through the West Indian region." We might restate this as a sort of zoögeographic law: any taxonomic category (genus, species, choromorph) found in Cuba and Jamaica will also be found in Hispaniola.

Several apparent exceptions to this will be found in the distributions given in the taxonomic part of this paper, but they almost all involve Lycaenids or Hesperiids now known only from Cuba and Jamaica: forms that will almost certainly be found in Hispaniola when more collecting has been done there. The only exception with any real significance in the butterflies is that of *Phyciodes pelops*, supposedly with one choromorph in Cuba and Jamaica, and another in Hispaniola; and in this case I have not been able to study specimens from all three islands.

Until a great deal of material from all islands is available for study, speculation as to the significance of this apparent order in Antillean distribution is somewhat idle.

Distinctness of Fauna. While our table of genera shows that the fauna is fairly homogeneous, it does not give any indication of its distinctness, beyond the two peculiar genera *Lucinia* and *Calisto.* An examination of the species, however, shows that nearly half are specifically distinct from any known continental forms, and considerably more than half are subspecifically distinct. A residue of about 30% of the West Indian species are common to all of the islands and to wide areas on the mainland. This 30% probably consists of species that today fly from island to island with some frequency. As an alternative, however, it may represent very stable species: we must remember that some of the Oligocene amber ants are indistinguishable from modern species, and if ants sometimes show such stability, we may expect it also in other insect groups. Our information is too limited to permit any sound inferences.

Summary. In theory, then, we can conveniently divide the Antillean butterflies into three groups: the first including peculiar and local species, which may have arrived by way of some pre-Miocene land connection, and which thus represent fragments of what may have been once a rich fauna; second, species that have arrived by chance, probably only once or twice, and become established, being isolated for a sufficient length of time to allow for the formation of distinct insular choromorphs; and third, the wide ranging species, that presumably pass from island to island with sufficient frequency to prevent the formation of insular choromorphs, or to keep these choromorphs from developing sharply differentiated characteristics. It would be rash to attempt to assign each species to one or another of these categories, but it seems to me that when we examine the fauna as a whole, the three tendencies stand out strongly.

In summary, we may say that the Antillean butterfly fauna is characterized by its poverty of species, by wide ranging genera, by the absence of many important groups that are well developed in neighboring faunas, and that it is fairly homogeneous and distinct from the other subdivisions of the Neotropical region.

References. Besides the papers cited above, Pagenstecher (1907) has written on the distribution of the Lepidoptera of the West Indies. The papers by Barbour (1914) and by Barbour and Ramsden (1919) on the reptiles contain much material of general interest.

Relationships of the Cuban Fauna

If we analyse the distribution of the Cuban butterflies, using choromorphs as the basis of our calculations, we get the following results:

		%
Limited to Cuba	54	34.2
Cuba and Bahamas	5	3.2
Cuba and continent	19	12.3
Cuba, Hispaniola and continent	8	5.1
Cuba and Hispaniola	17	11.0
Cuba and Jamaica	1	0.7
Antilles in general	22	14.2
Wide ranging	30	19.3
	156	100.0%

These figures must be considered as approximations, since our knowledge of the distribution of butterflies in tropical America can by no means be called precise. Choromorphs have not been carefully studied in the American faunas, and probably some of the supposedly wide ranges are based on misdeterminations. The butterflies of Hispaniola, of the Bahamas, and of many areas on the mainland are imperfectly known. Nevertheless the general trend of such a table is probably correct and significant.

The forms limited to Cuba include two types: those with close relatives in neighboring areas, and those without such relatives. To the latter class would belong the so-called relict species, of which *Papilio gundlachianus* is the outstanding Cuban example. The genera *Anetia* and *Calisto* are also apparently relict types. Most of the Cuban forms, however, are obviously local modifications of widespread species.

The Cuban fauna includes many Central American forms that have not reached the other Antillean islands, and in several cases the Cuban choromorph of a species is identical with the Central American form, while the other islands are inhabited by distinct and local subspecies. It looks as though these forms had crossed the Yucatan Channel; yet it is farther from Yucatan to Cuba than it is from Cuba to Jamaica, and there is certainly no general interchange across this last gap. Species with such Central American affinities include *Papilio polydamas*, *Eurema nise*, *E. boisduvaliana*, *Anteos clorinde*, *Phoebis statira*, *Danaus bereniee*, *Dynamine mylitta*.

The Florida-Bahamas-Cuba relationship is also very interesting. The Bahamas seem to play the rôle of half-way station between Florida and Cuba. Many Cuban species (*Calisto, Athena eleuchea*) are found in the Bahamas, but do not reach Florida; some Florida species (*Proteides zestos*) reach the Bahamas, but not Cuba. On the other hand, when the Bahamas and Cuba are inhabited by distinct choromorphs, Florida specimens may show intermediate or mixed characters (*Colaenis;* the Pericopid moth *Composia fidelissima* is a fine example). The Florida fauna itself is a curious mixture of Central American and Antillean elements.

Taxonomy

Nomenclature. The arrangement of species, genera and families used here is largely adapted from that found in Volume V of the Macrolepidoptera (Seitz), except where this has been supplanted by subsequent revisional work. The entire classification of the butterflies, built largely on superficial characters, is badly in need of revision, but if such revision is to be thorough and sound, the entire world fauna must be taken into consideration. The usual arrangement of Lepidoptera, starting with supposedly specialized groups and ending with generalized forms, is directly opposed to the arrangement used everywhere else in zoölogy, and should eventually be changed. A reversal of this sort, however, in a small faunal paper, would probably be more trouble than help.

The nine families into which the Cuban butterflies are placed do not represent any considered opinion on my part, but are merely the reflection of what seems to be the conservative tendency of lepidopterists. The subfamily question has been sidestepped by omitting all reference to such a category.

It has been necessary to check the history of every generic and specific name used, and even so various points that depend on exotic species could not be settled, and it is almost certain that some pertinent names and type fixations have been overlooked, because the forms directly involved have not been associated with the Cuban fauna. My object has been to place the nomenclature of the Cuban butterflies on a sufficiently firm basis so that future students of the fauna will have a minimum of bother with what should be a minor problem. This has resulted in numerous unfamiliar names and combinations; but these changes seem inevitable, as there is no standard list of American butterflies of sufficient accuracy and consistency to be used as a guide.

The taxonomist's preoccupation with nomenclature has caused some of our fellow zoölogists to heap a deal of ridicule on us, probably in part justified, but also in part based on a misunderstanding of the problem that faces us. Scientific names are essentially *terms for definitions*, as Karl Jordan has pointed out, and as such the precise identification of a given term with a given definition is obviously of major importance, if we are to gain any accuracy in the transmission of our ideas. It is also important, if hopeless confusion is to be avoided, that a given term should be generally recognized as the proper one for a given definition. The various rules of nomenclature that have been proposed for zoölogy aim at placing the selection of a particular term on a purely objective basis, in the hope of thereby achieving this general recognition; with the number of known animal forms fast approaching the million mark, these considerations acquire an added importance. Complete stability of nomenclature is probably both impossible and undesirable, insofar as nomenclature reflects the development of our knowledge and ideas; but it is both possible and desirable insofar as it concerns the association of a given term with a given nuclear, or "type," definition. And if our colleagues laugh because we change the name of an animal, we may gain some comfort by remembering the shifting nomenclature of enzymes, or the impressive synonymy of such a word as "mitochondria."

I have tried to follow the International Rules (1926) as closely as possible in selecting the names used in this paper. The two or three cases in which I have knowingly deviated from the rules all involve groups entirely foreign to the subject of this paper (see under genus XXIV, *Vanessa*, and XLV, *Strymon*). Two Linnean names, *Papilio plexippus* and *Papilio monuste*, of very uncertain application, are involved in the Cuban list. Both names will probably eventually require *nomina conservanda* rulings, and in the meanwhile, I have followed what seemed to be the simplest course consistent with the probabilities, in applying the names.

Explanation of terms. An effort has been made to use the most simple and obvious characters possible in preparing the keys and descriptions used in this paper; some word of explanation may not, however, be amiss. Characters taken from the antennae, the palpi and the eyes have occasionally been used. Figures 5 and 7 show profiles of the head, with the palpi. The palpus in butterflies always consists of three segments, usually not visible because of the covering of scales. The last, or third, segment is very useful in classification, as it is quite easily

seen, and varies markedly in relative size and shape. The tongue or proboscis lies curled between the two palpi. The antennae are always clubbed, or at least thickened toward the tip; their relative length, and

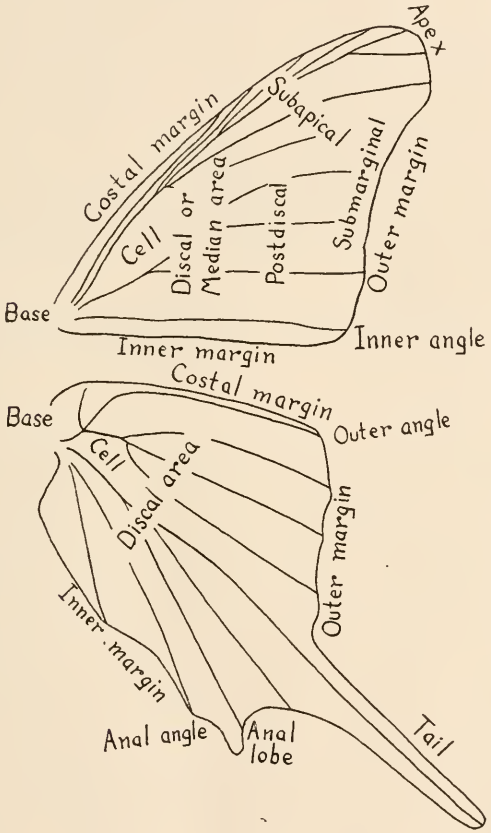

Fig. 2. Outline of wing to show parts. (*Athena chiron*)

the character of the club, are often mentioned in the keys. The eyes are sometimes *hairy*, that is, one can see fine hairs over their entire surface with the aid of a hand lens.

Almost no characters based on the thorax or abdomen are used in this paper. The structure of the legs varies greatly in different butter-

flies, but as this structure is sometimes difficult to see, it has not been used in the keys.

The Comstock-Needham system of naming the wing veins has been used here, as it is usually taught in American schools, and is about as convenient as any. The first vein of the forewing is the *subcostal* (Sc); it is never branched. The next is the *radius* (R), typically with five branches, although one or more of these may be absent. The next three veins belong to the *median* system (M_1, M_2, M_3); the next two to the *cubital* (Cu); and the remaining one or two free veins are *anal* veins (2A and 3A; 1A is absent in the butterflies).

The veins of the hindwing are similar, except that there is only one radial vein (Rs). A small Y-shaped vein at the base of the subcostal of the hindwing is called the *pre-costal* vein (PC). All of the important venation types are illustrated, so that there should be little difficulty in identifying the veins.

Figure 2 shows the outline of the wings of a butterfly, with the various areas used in describing the color pattern labelled. There should be no difficulty with these.

Diagnosis of butterflies. The butterflies, in the sense of the word used here, constitute one of the superfamilies of the order Lepidoptera: the *Papilionoidea*. The following diagnosis is adapted from Forbes: The hindwing is much shorter and broader than the forewing, with only a single free radial vein; the forewing has the cubitus straight to the base, sometimes with a rudiment of 1A arising from it near the base, but with the rest of A1 lost. There is no jugum nor frenulum connecting the two wings, but the humeral angle of the hindwing is enlarged, usually with a precostal vein. The antennae are usually more or less obviously clubbed, or at least thickened toward the tip; they are never plumose or pectinate. The tongue and labial palpi are always strong: the ocelli and maxillary palpi are always absent.

In the Cuban fauna, any day-flying insect with a coiled proboscis, with membranous, scaled wings, and with simple antennae, thicker toward the tip than toward the base, is a butterfly.

CHECK LIST OF CUBAN BUTTERFLIES

Papilio Linnaeus
1. *gundlachianus* Felder & Felder
2. *devilliers* Godart
3. *polydamas polydamas* Linnaeus
4. *polyxenes polyxenes* Fabricius
5. *thoas oviedo* Gundlach
6. *cresphontes* Cramer
7. *caiguanabus* Poey
8. *aristodemus temenes* Godart
9. *andraemon andraemon* (Hübner)
10. *androgeus epidaurus* Godman & Salvin
11. *pelaus atkinsi* subsp. nov.
12. *oxynius* (Hübner)
13. *celadon* Lucas

Pieris Schrank
14. *phileta phileta* (Fabricius)
15. *menciae* Ramsden

Appias Hübner
16. *ilaire poeyi* Butler

Melete Swainson
17. *salacia* (Godart)

Eurema Hübner
18. *lucina* (Poey)
19. *daira palmira* (Poey)
20. *elathea* (Cramer)
21. *messalina messalina* (Fabricius)
22. *nicippe* (Cramer)
23. *boisduvaliana* (Felder & Felder)
24. *amelia* (Poey)
25. *proterpia proterpia* (Fabricius)
26. *gundlachia* (Poey)
27. *nise* (Cramer)
28. *lisa* (Boisduval & Leconte)
29. *dina dina* (Poey)

Phoebis Hübner
30. *sennae sennae* (Linnaeus)
31. *philea thalestris* (Illiger)
32. *avellaneda* (Herrich-Schäffer)
33. *argante rorata* (Butler)
34. *agarithe agarithe* (Boisduval)
35. *statira jada* (Butler)
36. *neleis* (Boisduval)
37. *orbis* (Poey)

Anteos Hübner
38. *maerula maerula* (Fabricius)
39. *clorinde nivifera* (Fruhstorfer)

Kricogonia Reakirt
40. *lyside* (Godart)
41. *cabrerai* Ramsden

Zerene Hübner
42. *cesonia cesonia* (Stoll)

Nathalis Boisduval
43. *iole* Boisduval

Dismorphia Hübner
44. *cubana* (Herrich-Schäffer)

Danaus Kluk
45. *plexippus plexippus* (Linnaeus)
46. *gilippus berenice* (Cramer)
47. *ercsimus* (Cramer)

Lycorea Doubleday
48. *ceres demeter* Felder & Felder

Anelia Hübner
49. *numidia* Hübner
50. *pantherata clarescens* (Hall)
51. *cubana* (Salvin)

Hymenitis Hübner
52. *cubana* Herrich-Schäffer

Calisto Hübner
53. *herophile* Hübner

Heliconius Kluk
54. *charithonia charithonia* (Linnaeus)

Eueides Hübner
55. *cleobaea cleobaea* Geyer

Colaenis Hübner
56. *julia nudeola* Stichel

Dione Hübner
57. *vanillae insularis* (Maynard)

Euptoieta Hübner
58. *hegesia* (Cramer)

Phyciodes Hübner
59. *phaon phaon* (Edwards)
60. *pelops aegon* (Fabricius)
61. *frisia frisia* (Poey)

Chlosyne Butler
62. *perezi perezi* (Herrich-Schäffer)

Vanessa Fabricius
63. *atalanta* (Linnaeus)
64. *virginiensis virginiensis* (Drury)
65. *cardui* (Linnaeus)
Hypanartia Hübner
66. *paullus* (Fabricius)
Precis Hübner
67. *coenia* (Hübner)
68. *zonalis* (Felder & Felder)
Anartia Hübner
69. *jatrophae jamaicensis* Möschler
70. *lytrea chrysopelea* Hübner
Metamorpha Hübner
71. *stelenes insularis* (Holland)
Athena Hübner
72. *chiron* (Fabricius)
73. *eleuchea eleuchea* (Hübner)
Hypolimnas Hübner
74. *misippus* (Linnaeus)
Historis Hübner
75. *odius odius* (Fabricius)
Coea Hübner
76. *acheronta* (Fabricius)
Colobura Billberg
77. *dirce* (Linnaeus)
Lucinia Hübner
78. *sida* Hübner
Eunica Hübner
79. *tatila tatila* (Herrich-Schäffer)
80. *monima habanae* Seitz
81. *pusilla fairchildi* subs. nov.
82. *macris heraclitus* Gundlach
Dynamine Hübner
83. *egaea zetes* (Ménétriés)
84. *mylitta bipupillata* Röber
Adelpha Hübner
85. *iphicla iphimedia* Fruhstorfer
Doxocopa Hübner
86. *laure druryi* (Hübner)
Asterocampa Röber
87. *lycaon idyja* (Hübner)
Prepona Boisduval
88. *antimache crassina* Fruhstorfer

Siderone Hübner
89. *nemesis nemesis* (Illiger)

Anaea Hübner
90. *clytemnestra iphigenia* (Lucas)
91. *troglodyta cubana* (Druce)
92. *verticordia echemus* (Doubleday, Westwood & Hewitson)

Libythea Fabricius
93. *carinenta motya* (Hübner)

Apodemia Felder & Felder
94. *carteri ramsdeni* (Skinner)

Eumaeus Hübner
95. *atala* (Poey)

Strymon Hübner
96. *coelebs* (Herrich-Schäffer)
97. *martialis* (Herrich-Schäffer)
98. *acis* (Drury)
99. *favonius* (Abbot & Smith)
100. *simaethis* (Drury)
101. *maesites* (Herrich-Schäffer)
102. *celida* (Lucas)
103. *columella* (Fabricius)
104. *angelia* (Hewitson)
105. *gundlachianus* sp. nov.

Hemiargus Hübner
106. *filenus* (Poey)
107. *ammon* (Lucas)

Brephidium Scudder
108. *isophthalma* (Herrich-Schäffer)

Leptotes Scudder
109. *theonus* (Lucas)

Phocides Hübner
110. *batabano batabano* (Lucas)

Goniurus Hübner
111. *marmorosa* Herrich-Schäffer
112. *dorantes santiago* (Lucas)
113. *proteus* (Linnaeus)

Proteides Hübner
114. *exadeus maysi* (Lucas)
115. *asander* (Hewitson)
116. *mercurius sanantonio* (Lucas)

Polygonus Hübner
117. *lividus* Hübner

Telegonus Hübner
118. *talus* (Cramer)
119. *anaphus cubanus* Mabille & Boullet
120. *jariba jariba* (Butler)
121. *xagua* (Lucas)
122. *alardus habana* (Lucas)

Cabares Godman & Salvin
123. *potrillo potrillo* (Lucas)

Achlyodes Hübner
124. *thraso papinianus* (Poey)

Ephyriades Hübner
125. *zephodes zephodes* (Hübner)
126. *arcas* (Drury)
127. *cubensis* Skinner

Pholisora Scudder
128. *concolor* (Herrich-Schäffer)
129. *braco* (Herrich-Schäffer)

Chiomara Godman & Salvin
130. *mithrax* (Möschler)

Erynnis Schrank
131. *gesta* (Herrich-Schäffer)
132. *zarucco* (Lucas)

Pyrgus Hübner
133. *syrichtus* (Fabricius)
134. *crisia* Herrich-Schäffer

Ancyloxypha Felder
135. *nanus* (Herrich-Schäffer)

Adopaea Billberg
136. *magdalia* (Herrich-Schäffer)

Hylephila Billberg
137. *phyleus* (Drury)

Atalopedes Scudder
138. *mesogramma* (Latreille)

Polites Scudder
139. *baracoa* (Lucas)

Catia Godman
140. *misera* (Lucas)

Poanes Scudder
141. *radians* (Lucas)

Lerema Scudder
142. *cornelius* (Latreille)

Phemiades Hübner
143. *antiqua antiqua* (Herrich-Schäffer)

Lerodea Scudder
144. *eufala* (Edwards)
145. *tripuncta* (Herrich-Schäffer)

Calpodes Hübner
146. *ethlius* (Cramer)

Prenes Scudder
147. *nero sylvicola* (Herrich-Schäffer)
148. *ocola* (Edwards)
149. *panoquinoides* (Skinner)
150. *nyctelius coscinia* (Herrich-Schäffer)
151. *corrupta* (Herrich-Schäffer)

Asbolis Mabille
152. *capucinus* (Lucas)

Perichares Scudder
153. *coridon coridon* (Fabricius)

Paracarystus Godman
154. *cubana* (Herrich-Schäffer)

Godmania Skinner & Ramsden
155. *malitiosa* (Herrich-Schäffer)

Thracides Hübner
156. *telegonus* (Esper)

Key to Families

1. Forewing with R five-branched, all of the branches simple, unforked, arising from the cell (figs. 18–24); antennae separated at the base by a distance greater than half of the width of the eye, often with a sharp hook at the tip (the apiculus; fig. 17). Family IX ..... *Hesperiidae*
   F.w. with some of the branches of R stalked or absent; antennae closer together, the club never with an apiculus..... 2
2. F.w. with Cu apparently four-branched (that is, M_2 arises from the cubital stem), and with two or three anal veins; h.w. with only one anal vein (fig. 3). Family I..... *Papilionidae*
   F.w. with Cu apparently three-branched, and with only one anal vein completely developed, although a second may be present at the base; h.w. with two anal veins 3
3. Palpi much longer than thorax ..... Family VI. *Libytheidae*
   Palpi not as long as thorax 4

4. R of f.w. with five branches[1]; both sexes with forelegs greatly reduced, not functional, except in the Pierid *Dismorphia*.....7
   R of f.w. with only three or four branches; six well developed legs in female, and usually also in male, although they may be somewhat reduced.....5
5. Vein M_1 of f.w. united with a branch of the radius for a considerable distance beyond the apex of the discal cell (figs. 4, 6); usually white, yellow or orange insects..... Family II. *Pieridae*
   M_1 of f.w. arising at or near the apex of the discal cell; usually small, dark colored insects.....6
6. PC vein of h.w. present; one small brownish-grey species in Cuba, very rare.....Family VII. *Riodinidae*
   PC vein absent (figs. 15, 16); small dusky or blue insects, often very common.....Family VIII. *Lycaenidae*
7. All six legs functional; f.w. elongate (fig. 7). (Genus *Dismorphia*). Family II. *Pieridae*
   Forelegs greatly reduced, not functional.....8
8. Vein Sc of h.w. ending on the costal margin (figs. 9, 11).....9
   Vein Sc of h.w. extending to outer margin (figs. 12, 13).....10
9. Some of the veins of f.w. greatly swollen at the base[2] (fig. 11); the only Cuban species is a small grey butterfly. Family IV. *Satyridae*
   Veins of f.w. not swollen at base.....Family III. *Danaidae*
10. Wings transparent (one Cuban species; fig. 10, venation). Family III. *Danaidae*
    Wings fully clothed with scales.....Family V. *Nymphalidae*

Family I. PAPILIONIDAE

The Cuban Papilionidae are all large butterflies, and with the exception of *P. polydamas*, all bear a tail at vein M_3 of the hindwing. They are easily distinguished from all other groups by the position of M_2 of the forewing, which arises directly from the cubital stem, making that system apparently four-branched.

Since the days of Hübner, the tropical American swallowtails have all been lumped in the one genus *Papilio*. It is unfortunate that

[1]To determine the number of branches of the radius, count the two cubital and three medial branches first; the branches left between M_1 and Sc then belong to the radius.

[2]Two genera of Cuban Nymphalidae, *Eunica* and *Lucinia*, have the veins at the base of the forewing swollen; in both of these the precostal vein of the hindwing is well developed, while it is absent in the Satyrid genus *Calisto*.

Rothschild and Jordan never completed their proposed generic revision of the group, and it is to be hoped that some capable student of the butterflies will take up the task where they left it and carry on. The Cuban species fall into six natural groups, which correspond to the genera of other butterfly families. These groups are:

1. *Hectorides* Hübner, genotype *Papilio agavus* Drury, including the first Cuban species;
2. *Laertias* Hübner, genotype *Papilio philenor* Linn., including species no. 2 and 3;
3. *Papilio* Linnaeus, genotype *Papilio machaon* Linn., including species no. 4;
4. *Heraclides* Hübner, genotype *Papilio thoas* Linn., including species 5 to 10;
5. *Pterourus* Scopoli, genotype *Papilio troilus* Linn., including species no. 11 and 12;
6. *Iphiclides* Hübner, genotype *Papilio podalirius* Linn., to which species no. 13 might well be assigned.

Genus I. Papilio Linnaeus

Genotype, *Papilio machaon* Linn.

This generic name is used here in the broad sense, in conformity with general practise.

Key to species

1. Underside of abdomen solid yellow 2
   Underside of abdomen not yellow; at most with small yellow spots on the side 6
2. Upper surface of f.w. with some yellow in the cell, a spot or band . 3
   Cell of f.w. wholly dark above 4
3. Yellow median band of wings above very wide, occupying about half of the wing area; tail slender, wholly black; yellow in the cell of f.w. forming an irregular spot . 10. *P. androgeus epidaurus*
   Yellow median band narrower; tail somewhat spatulate, with a yellow spot near tip; a yellow bar across the cell of f.w. near the distal end . . . . . 9. *P. andraemon andraemon*

4. Brown on under surface of h.w. confined to two spots, between veins Cu_1–M_3 and M_3–M_2 5
   The brown area extends across the entire wing, and is bordered distally by the median blue spots .... 8. *P. aristodemus temenes*
5. The fifth yellow spot of the discal row on f.w. above, counting from the apex (the spot between M_2 and M_3) is larger than the following spot; the submarginal yellow lunule of this area either absent or barely indicated ..... 6. *P. cresphontes*
   The fifth spot about the same size as the sixth, with a well developed lunule just distal to it ..... 5. *P. thoas oviedo*
6. Wings with light green bars and spots; tails long and slender. 13. *P. celadon*
   Wings not so marked 7
7. A submarginal row of red spots on h.w. beneath 10
   Submarginal spots of under surface of h.w. yellow, sometimes partly orange 8
8. F.w. without submarginal yellow spots above; either entirely black, or with three or four large yellow spots on the disc, near the apex of the cell ..... 10. *P. androgeus epidaurus*
   F.w. with a row of submarginal yellow spots 9
9. H.w. below with a yellow and brown spot in the cell; two complete rows of light spots across both wings—a median and a submarginal row ..... 4. *P. polyxenes polyxenes*
   H.w. below with no markings in the cell; only the submarginal row of spots developed on f.w. above ..... 7. *P. caiguanabus*
10. F.w. above with a prominent band of iridescent blue. 1. *P. gundlachianus*
    No such band 11
11. Both wings above with submarginal rows of light spots; the wings show greenish reflections 12
    No submarginal spots on f.w. above 13
12. Tailed; under side of h.w. with broad whitish marginal spots. 2. *P. devilliers*
    No tails; margin of h.w. edged thinly with yellow between the veins ..... 3. *P. polydamas polydamas*
13. F.w. with a creamy band from the costa to the inner angle. 11. *P. pelaus pelaus*
    This band absent, or only partially developed, never reaching the inner angle ..... 12. *P. oxynius*

1. Papilio gundlachianus

Fig. 3, venation

Papilio columbus Herrich-Schäffer (*nec* Hewitson), 1862, p. 141; 1864b, p. 170; Rothschild and Jordan, 1906, p. 436; Jordan in Seitz, V, p. 12, pl. 1a (1907); Bryk, 1930, p. 316.

Papilio gundlachianus Felder & Felder, 1864, p. 294; *id.*, Reise Novara, p. 137; Gundlach, 1881, p. 124; Honrath, 1886, p. 131, pl. 5, f. 5; *id.*, 1887, p. 321, pl. 5, f. A; Bonzon, 1888, p. 293; Gundlach, 1891, p. 450.

Papilio grotei Blake, 1865, p. 313.

Blakea gundlachianus: Grote, 1875, p. 118.

The iridescent blue band of the forewing will distinguish this species at a glance from anything else found in Cuba. The ground color is black, the forewing crossed by a discal blue band from the middle of the costa to the inner angle, and with two or three blue spots on the apex; the hindwing has three or four prominent red spots at the inner angle: a rich deep red in the winter specimens, duller, almost orange, in the summer individuals. The tail of the hindwing is well developed, and the outer margin is somewhat produced at all of the vein endings. Beneath there is a complete row of red submarginal spots on the hindwing. The inner margin of this wing is folded in the male, enclosing a woolly white scent organ. Length of f.w., 40–50 mm.

Metamorphosis. The larva has been described by Bonzon, Honrath and Gundlach; it lives on *Aristolochia*.

Distribution. This species seems to be confined to the Cuban province of Oriente; it is not very closely related to any other known species. In the M.C.Z. there are 15 specimens from Sardinero, San Carlos and Torquino, taken in January, April and July.

2. Papilio devilliers

Papilio devilliers Godart, 1819, p. 810 [1824]; Poey, 1846, p. 235; Rothschild and Jordan, 1906, p. 514; Jordan in Seitz, V, p. 20, pl. 6a (1907).

Papilio villiersii: Lucas, 1857, p. 485.

Papilio devilliersi: Herrich-Schäffer, 1864b, p. 170; Holland, 1931, p. 313, pl. 70, f. 1; Bryk, 1930, p. 365, 626.

Papilio devilliersii: Gundlach, 1881, p. 123.

This species is similar to the common North American *P. philenor* on the upper surface, but quite differently marked beneath. The ground color is black, overcast with green on much of the upper side

of both wings; there is a complete row of submarginal spots, whitish on the forewing, light blue on the hindwing; the tail is well developed. The under side of the forewing has a marginal and submarginal row of

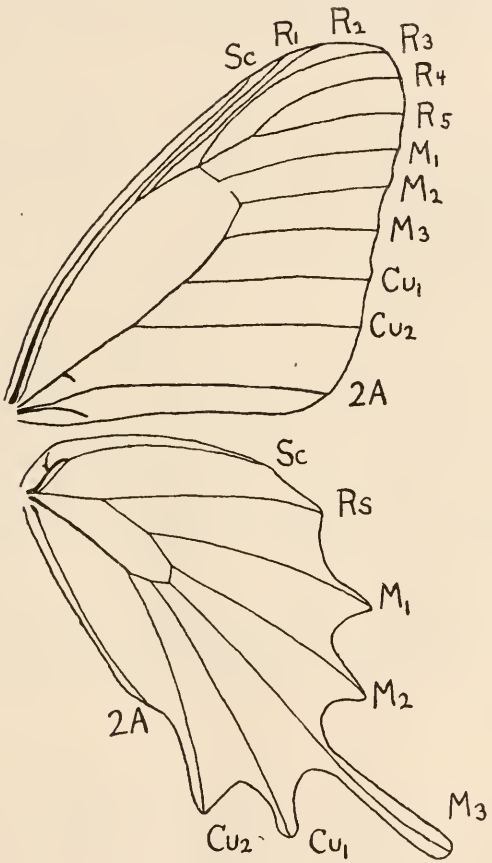

Fig. 3. *Papilio gundlachianus*, venation.

white, triangular spots; on the hindwing there is a submarginal row of dull red spots, bordered externally with silver. Length of f.w., 40–50 mm.

Met. Gundlach mentions that the larva feeds on *Aristolochia*, but he does not describe it.

Dist. P. devilliers has been recorded from Florida and Cuba; it has not, however, been taken in Florida in recent years, and the record needs confirmation. The related *P. zetes* of Hispaniola, which I have not studied, is considered to be specifically distinct. There are 18 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana.

3. Papilio polydamas polydamas

Papilio polydamas Linnaeus, 1758, p. 460; Poey, 1846, p. 236; Herrich-Schäffer, 1864, p. 170; Gundlach, 1881, p. 121; *id.*, 1891, p. 450; Bryk, 1930, p. 367, 626; Holland, 1931, p. 312, pl. 41, f. 4.

Papilio polydamas polydamas: Rothschild and Jordan, 1906, p. 520; Jordan in Seitz, V, p. 21, pl. 6b (1907).

This protean butterfly, which seems to have formed a distinct choromorph on every West Indian island, is represented in Cuba by specimens that, for the most part, cannot be distinguished from those found on the mainland of Central America. The upper side of the wings is black, with green reflections over much of the surface, and with a complete row of golden submarginal spots, large and quadrangular, on the hindwing. The under side is lighter, with narrow red submarginal spots on the hindwing. Length of f.w., 40–50 mm.

Met. The larva, often described, lives on various species of *Aristolochia*.

Dist. This butterfly is very widely spread in the tropics of continental America; in Cuba, it is common wherever its food plant grows (Gundlach). In the M.C.Z. there are 15 specimens from Oriente, Camagüey, Sta. Clara (Soledad) and Habana.

4. Papilio polyxenes polyxenes

Papilio polyxenes Fabricius, 1775, p. 444; Gundlach, 1881, p. 136; Bryk, 1930, p. 381.

Papilio asterias: Poey, 1846, p. 235; Lucas, 1857, p. 480.

Papilio asterius: Herrich-Schäffer, 1864b, p. 169.

Papilio polyxenes polyxenes: Rothschild & Jordan, 1906, p. 547; Jordan in Seitz, V, p. 23, pl. 8a (1907).

The sexes of this species are somewhat dissimilar. Both have two complete rows of yellow spots on the outer half of the wings: the submarginal spots small, rounded; the inner spots larger, especially

in the male, where they cover the disc of the hindwing. There is a variable amount of blue scaling between these two rows of yellow spots, confined to the hindwing in the male, more extensive in the female. The anal spot of the hindwing has a black pupil, circled by orange above, yellow below. The under surface repeats the pattern of the upper, but many of the spots, especially on the hindwing, are orange rather than yellow. Length of f.w., 42–48 mm.

The name *polyxenes* is used here in the restricted sense given it by Rothschild and Jordan. It is very unlikely that Fabricius had Cuban specimens, as no other butterflies peculiar to Cuba were described by him; it would seem, however, that Rothschild and Jordan were quite justified in their procedure of selecting a type locality for the name, and there is certainly no object in introducing further changes. *P. polyxenes* Fabricius is not preoccupied by *P. polixenes* Fabricius, as listed by Barnes and Benjamin (1926, p. 5), as the former name has page precedence.

Met. The life history of *P. polyxenes asterius* has often been described, and Gundlach has described the larva of the Cuban form. Various plants of the family Umbelliferae serve as hosts.

Dist. The Cuban form differs from the North American chiefly in the broader discal band of the hindwing in both sexes, and in the larger submarginal spots of the under surface. Choromorphs have been described from South and Central America, but the species is known only from Cuba in the West Indies. Gundlach supposed that it was introduced from North America, but the racial differences would seem to preclude the possibility of this introduction having occurred within historic times. It has been found only in the vicinity of Habana, whence there are 6 specimens in the M.C.Z.

5. Papilio thoas oviedo

Papilio thoas: Poey, 1846, p. 234.
Papilio cresphontes: Herrich-Schäffer, 1864b, p. 169 (*part.*)
Papilio oviedo Gundlach, 1866, p. 279, pl. 5, f. 1, 2; *id.*, 1881, p. 133.
Papilio cresphontes var. *oviedo:* Gundlach, 1886, p. 132.
Papilio thoas oviedo: Rothschild & Jordan, 1906, p. 557; Jordan in Seitz, V, p. 24 (1907).
Papilio thoas var. *oviedo:* Bryk, 1930, p. 395, 628.

The Cuban *thoas* may be distinguished from *cresphontes* by the wider discal band of the forewing, the less developed anal spot of the hindwing, and the larger size of the blue spots of the under side of the

hindwing, as well as by the character used in the key. Length of f.w., 48–58 mm.

Met. Gundlach bred this species from a pupa found on the trunk of Ayúa (*Zanthoxylum*).

Dist. Papilio thoas is very widely distributed in tropical America, and many subspecies have been described; *oviedo* from Cuba and *melonius* from Jamaica are the only known Antillean choromorphs. There are 5 specimens in the M.C.Z. from the Trinidad Mts. in Sta. Clara: San Blas and Buenos Aires, 2000 to 3000 ft., July and August. The U.S.N.M. specimens are from Oriente: Santiago and Baracoa.

6. Papilio cresphontes

Papilio cresphontes Cramer, Pap. Ex., II, p. 106, 107, pl. 165, f. A, 166, f. B (1777); Herrich-Schäffer, 1862, p. 141; *id.*, 1864b, p. 169 (*part.*); Gundlach, 1881, p. 131; Rothschild & Jordan, 1906, p. 562; Jordan in Seitz, V, p. 24, pl. 7a (1907); Bryk, 1930, p. 398; Holland, 1931, p. 317, pl. 42, f. 3.

I have not seen any Cuban specimens of this species, but the records seem to be unquestionable. It may be distinguished by the characters mentioned under *oviedo* above. The male genitalia of the two species are very distinct, as *thoas* has a long dorsal process so slightly developed in *cresphontes* that a space may be seen between the claspers above, without dissection. Length of f.w., 50–60 mm.

Met. The larva has been described by Gundlach and by various writers on North American butterflies. Gundlach lists as food plants Ayúa (*Zanthoxylum*), Caisimon (*Piper peltatum* and *umbellatum*) and Platanillo (*Piper aduncum* and other species). It is a minor pest of oranges in Florida, a rôle that is taken over by *P. andraemon* in Cuba.

Dist. This species was described from New York, South Carolina and Jamaica (*alia sp.!*); it ranges from Canada through Central America, but in the West Indies it has been recorded only from Cuba where, according to Gundlach, it occurs generally over the island.

7. Papilio caiguanabus

Papilio caiguanabus Poey, 1854b, p. 442, pl. 15, f. 1, 2, 3, 4, [1852]; Lucas, 1857, p. 485; Herrich-Schäffer, 1862, p. 174; *id.*, 1864b, p. 170; Gundlach, 1881, p. 127; Rothschild & Jordan, 1906, p. 567; Jordan in Seitz, V, p. 25, pl. 8c (1907); Bryk, 1930, p. 403, 628.

This insect differs markedly from the other Cuban species of the *thoas* Group in that the ground color of the underside of the wings and abdomen is black. The usual yellow discal band is absent both above and below, on both wings, and in the female the submarginal band of the hindwing above is composed of very light blue spots, not yellow as in the male. The anal angle of the hindwing is marked with orange and blue as in the related species. The under side of the hindwing shows some blue spots between the veins on the disc, as well as two dark orange spots between veins M_2–M_3 and M_3–Cu_1. The large submarginal spots are light orange in the female, yellow in the male. Length of f.w., 43–50 mm.

Dist. This species is known only from Cuba; *Papilio aristor* of Hispaniola seems to be its closest relative. In the M.C.Z. there are 9 specimens from various localities in Oriente, from sea level to 1000 ft.; the U.S.N.M. material is from Oriente and Matanzas.

8. Papilio aristodemus temenes

Papilio temenes Godart, 1819, p. 63; Oberthur, 1897, p. 176, f. 4.
Papilio aristodemus: Poey, 1846, p. 235; Lucas, 1857, p. 483, pl. 16, f. 2, 2a.
Papilio cresphontinus: Gundlach, 1881, p. 130.
Papilio aristodemus temenes: Rothschild & Jordan, 1906, p. 569; Jordan in Seitz, V, p. 25, pl. 7c, (1907).
Papilio aristodemus var. *temenes:* Bryk, 1930, p. 404.

The pattern of this insect is very similar to that of *cresphontes* and *thoas,* but the ground color is lighter, brown rather than black, and the median spots are scarcely distinct, tending to fuse into a solid yellow band. The tail has no central yellow spot above. The most outstanding character of the under surface is the extension of the brown of the hindwing, pointed out in the key. Length of f.w., 52 mm.

Dist. The three known choromorphs of *aristodemus* inhabit Florida (*ponceana*), Cuba (*temenes*) and Hispaniola (the name type). *Temenes* is limited to Cuba, where Gundlach found it in the vicinity of Habana and Colon. Rothschild and Jordan list it from Gibara (north coast of Oriente). There is one female in the M.C.Z. from Oriente (Santiago de Cuba); the U.S.N.M. specimens are from Santiago de Cuba and Matanzas.

9. Papilio andraemon andraemon

Heraclides andraemon Hübner, Ex. Schm., II, pl. 98, ff. 1, 2, (182–?).
Papilio andraemon: Poey, 1846, p. 235; Lucas, 1857, p. 476; Herrich-Schäffer, 1864b, p. 169; Gundlach, 1881, p. 128; Holland, 1916, p. 500; Bryk, 1930, p. 405, 628.
Papilio andraemon andraemon: Rothschild & Jordan, 1906, p. 571; Jordan in Seitz, V, p. 25, pl. 8b (1907).

This is one of the commonest Cuban Papilios. It is easily distinguished from its congeners by the broad, solid yellow band across both wings, the absence of submarginal spots on the forewing, the long tails, and the yellow bar in the cell of the forewing. Length of f.w., 45–52 mm.

Met. The larva, which feeds on *Citrus* and *Ruta,* was described by Gundlach.

Dist. This species is known from Cuba (name type), the Bahamas (*bonhotei*) and Great Cayman (*tailori*). In the M.C.Z. there are 32 specimens from Oriente, Camagüey, Sta. Clara (Soledad), Habana and the Isle of Pines; there are specimens in the U.S.N.M. from Matanzas.

10. Papilio androgeus epidaurus

Papilio polycaon: Poey, 1846, p. 234; Lucas, 1857, p. 479; Herrich-Schäffer, 1862, p. 141; Gundlach, 1881, p. 134; *id.*, 1891, p. 454.
Papilio epidaurus Godman & Salvin, Biologia, 2, p. 224, pl. 69, f. 1, 2, 3 (1890).
Papilio androgeus epidaurus: Rothschild & Jordan, 1906, p. 578; Jordan in Seitz, V, p. 26 (1907).
Papilio androgeus var. *epidaurus:* Bryk, 1930, p. 413.

The male has a very broad yellow discal band across both wings, and a slender black tail. Beneath it is mostly yellow, with submarginal rows of blue and brown spots on the hindwing. Central American females which, according to Rothschild and Jordan, are the same as the West Indian ones, are deep blue over most of the upper surface, with the apex of the cell yellow, and elongate yellow spots outside the cell between veins Cu_1 and M_1. Gundlach, however, describes the Cuban female as lacking the yellow on the forewing, and a single female in the M.C.Z. from Haiti agrees with this. Length of f.w., 67 mm. (Haiti).

Met. Gundlach found the larva on orange, lemon, and other species of *Citrus.*

Dist. Androgeus ranges over most of tropical America; the choromorph *epidaurus* was described from Central America, and it has been reported from various West Indian islands. It is impossible to be sure of the relationship of the Cuban and Hispaniolan form without more material, but it is almost certainly not *epidaurus*. Gundlach states that in certain places in Cuba where oranges are common, this species is not rare; the only Cuban specimen that I have seen is in the A. N. S. P., from Oriente (Guatanamo).

11. Papilio pelaus atkinsi subsp. nov.

Papilio pelaus: Herrich-Schäffer, 1862, p. 141; *id.*, 1864b, p. 170; Gundlach, 1881, p. 126; Bryk, 1930, p. 433, 631 (*part.*).

Papilio pelaus pelaus: Rothschild & Jordan, 1906, p. 603 (*part.*); Jordan in Seitz, V, p. 28, pl. 7b (1907) (*part.*).

The upper surface is black, with a creamy white band running almost straight from the inner angle of the forewing to the middle of the costa, and with similarly colored marginal lunules on the hindwing, where there are also several (4 in the male, 6 or 7 in the female) brick-red submarginal spots, extending upward from the anal angle. The tail is well developed, black. The under surface is similar to the upper, except that the submarginal red spots of the hindwing form a complete row, each spot edged with white. Length of f.w., 48 mm.

Met. Gundlach found a pupa on the trunk of Ayúa (*Zanthoxylum*); Cockerell (1893, p. 450) has given a brief description of the larva of the Jamaican form.

Dist. This choromorph is limited to Cuba, the name type is found in Jamaica, and another form (*imerius*) occurs in Hispaniola. The inclusion of the Cuban and Jamaican forms under one choromorph name, as is done by Rothschild and Jordan, gives a false impression of relationship. The Jamaican and Hispaniolan forms agree in the reduced red spots of the upper surface of the hindwing, but differ in the form of the cream band of the forewing; the Jamaican and Cuban forms agree in the form of the band on the forewing, but differ in the red spots of the hindwing, as Rothschild and Jordan pointed out. These spots are much larger in the Cuban form, almost entirely red, while the first spot, at least, in Jamaican specimens is usually yellow. This seems to be a rare species in Cuba, restricted to Oriente, according to Gundlach. In the M.C.Z. there is a single male from Guantanamo (April), the holotype.

12. Papilio oxynius

Laertias oxynius Hübner, Ex. Schm., III, pl. 3, f. 1, 2 (183–?).
Papilio augustus Boisduval, 1836, p. 358.
Papilio oxynius: Poey, 1846, p. 236; Herrich-Schäffer, 1864b, p. 170; Gundlach, 1881, p. 127; *id.*, 1891, p. 452; Rothschild & Jordan, 1906, p. 603; Jordan in Seitz, V, p. 28, pl. 10b (1907); Bryk, 1930, p. 434, 631.
Papilio (*Laertias*) *oxynius:* Lucas, 1857, p. 483.

This species is similar to *pelaus*, but the marginal lunules are much more strongly developed on both wings, the creamy transverse band of the forewing is usually absent in the male, and represented by only a few isolated spots in the female; the red submarginal spots of the hindwing also tend to disappear in the male, and are greatly reduced in the female. The under side of the hindwing has a discal row of small elongate white spots (reduced in the male) in addition to the submarginal red spots. Length of f.w., 42–45 mm.

Met. The larvae feed on Ayúa (*Zanthoxylum*) and are gregarious, according to Gundlach. They feed during the night, and rest by day in large colonies on the trunk of the tree.

Dist. This species has been reported only from Cuba where, according to Gundlach, it is found over the entire island. In the M.C.Z. there are 8 specimens from Oriente (Sierra Maestra, 1000 ft., Querci) and Sta. Clara (vicinity of Soledad): May, June, July, Sept. and Nov.

13. Papilio celadon

Papilio sinon: Poey, 1846, p. 236; Herrich-Schäffer, 1864b, p. 169.
Papilio celadon Lucas, 1852, p. 130; 1857, p. 478; Gundlach, 1881, p. 125; Rothschild & Jordan, 1906, p. 691; Jordan in Seitz, V, p. 39, pl. 14c (1907); Holland, 1916, p. 500; Bryk, 1930, p. 487, 634; Holland, 1931, p. 321, pl. 70, f. 11.

This insect may be at once distinguished from anything else occurring in Cuba by the pale green bands that take up a large part of the wing surface. There is a prominent red anal spot on the hindwing above, repeated below. Length of f.w., 30–40 mm.

Dist. P. celadon has been reported from Florida and Cuba; the related forms in Jamaica (*marcellinus*) and Hispaniola (*zonaria*) seem sufficiently distinct to be called "species" as we have defined the word. There are 11 specimens in the M.C.Z. from Oriente and Camagüey, July, Sept. and Oct.; the U.S.N.M. specimens are from Pinar del Rio (Santiago de los Baños and Guanajay).

Family II. PIERIDAE

The Pieridae form a characteristic group of butterflies, the "whites" and "yellows;" only the single rare species of *Dismorphia* is atypical in the Cuban fauna. The fact that all six legs are completely developed and functional will serve to separate the Pierids from the Nymphalids at a glance. Klots (1933) has recently revised the genera of the family.

Key to genera

1. Radius of f.w. five-branched; M_1 not fused with a radial branch at its base, arising free from the cell; wings elongate, black, marked with yellow and orange. (Fig. 8) .....XI. *Dismorphia*
   Radius of f.w. with three or four branches; M_1 fused with R_{3-4} for some distance beyond the tip of the cell; wings of normal shape, usually yellow, white or orange.....2
2. 3rd joint of palpus short, usually little more than a knob on the end of the 2nd joint. (Fig. 7.).....6
   3rd joint of palpus elongate, as long as or longer than the 2nd joint. (Fig. 5.) 3
3. R_3 and R_4 branch very close to the apex of the wing, and are very short; in the Cuban species R_3 is shorter than the distance between its end and R_4.....II. *Pieris*
   These veins longer: R_3 as long as or longer than the distance between its tip and the tip of R_4.....4
4. Precostal of h.w. present, well developed; ground color of upper surface, at least of f.w., white.....5
   Pc absent, or barely discernable as a slight knob; ground color of upper surface yellowish.....VI. *Phoebis* ♀
5. R_2 of f.w. arising near the apex of the cell; h.w. below with a straight dark line that touches the end of the cell, and is perpendicular to the costal margin. (Fig. 4.).....IV. *Melete*
   R_2 arising considerably before the end of the cell; no such bar on h.w. below.....III. *Appias*
6. Large butterflies, f.w. more than 30 mm. long; outer margin of f.w. above never broadly bordered with solid black; discocellular vein between M_2 and M_3 at end of cell of f.w. about equal in length to that between M_3 and Cu_1.....7
   Small butterflies, f.w. less than 30 mm. long; or if larger, with f.w. heavily bordered with black above; discocellular M_2–M_3 longer than M_3–Cu_1.....8

7. Apex of f.w. produced, falcate; h.w. toothed at M_3...VII. *Anteos*
   Apex of f.w. normal; h.w. not toothed at M_3 .....VI. *Phoebis*
8. Radius of f.w. with only three branches; small butterflies with elongate forewings.....X. *Nathalis*
   Radius of f.w. with four branches; wings normal in shape.....9
9. Antennae not distinctly clubbed, thickening gradually toward the tip; apex of f.w. produced, slightly falcate; f.w. heavily bordered with black above, and with a prominent round black spot at end of cell..... IX. *Zerene*
   Antennae with distinct club; apex of f.w. not especially pointed in Cuban species; wings not marked as described above.....10
10. Palpi long, projecting in front of head about as far as the eye is wide; usually greenish white butterflies, with base of f.w. orange; f.w. not bordered with black.....VIII. *Kricogonia*
    Palpi short, scarcely projecting in front of head; small, very common butterflies, yellow, orange or white, with f.w. more or less heavily margined with black in all Cuban species. (Fig. 6, 7).....V. *Eurema*

Genus II. Pieris Schrank

Genotype, *Papilio brassicae* Linnaeus.

Key to species

1. Outer margin of f.w. above with no black, or at most a faint edging of black.....15. *P. meneiae*
   Outer margin of f.w. bordered with black, which extends in on the veins.....14. *P. phileta*

14. Pieris phileta phileta

? *Papilio monuste* Linnaeus, 1764, p. 237.
Papilio phileta Fabricius, 1775, p. 471.
Pieris philete: Godart, 1819, p. 141.
Pieris evonima Boisduval, 1836, p. 493.
Pieris vallei Boisduval, 1836, p. 494; Lucas, 1857, p. 491, pl. 15, f. 1, 1a.
Pieris joppe Boisduval, 1836, p. 495; Lucas, 1857, p. 491, pl. 15, f. 2, 2a.
Pieris monuste: Poey, 1846, p. 298; Herrich-Schäffer, 1864b, p. 168; Gundlach, 1881, p. 100; Holland, 1916, p. 496.
Pieris monuste evonina: Röber in Seitz, V, p. 53 (1909).
Ascia monuste: Holland, 1931, p. 278, pl. 35, f. 1, 2; pl. 67, f. 15, 16, 17, 18.
[*Pieris*] *phileta:* Talbot, 1929, p. 56.
Ascia monuste evonima: Talbot, 1932, p. 209.

Cuban males are usually white on both surfaces, the forewing heavily bordered with black on the outer margin above, projecting inward on the veins. The females are darker, with the wings more heavily bordered with black, and with the under side tending to become mottled. In all except two of our Cuban females there is an isolated black spot at the tip of the cell of the forewing. Length of f.w., 25–30 mm.

This butterfly, which ranges widely over the American tropics, is very variable, both individually and geographically, and it has received an amazing number of names. Talbot (1929) has discussed the application of the name *monuste* at some length. There are three possible interpretations of this name: (1), it may apply to the North American insect, as determined by Fabricius (1775, p. 470); (2), it may be a Chinese species, as figured by Cramer (1777, Pap. Ex., 2, pl. 141, f. F), and as pointed out by Godart (1819, p. 141); or (3), it may be the South American form figured by Hübner (Samm. Ex. Schm., 1, pl. 137), as fixed by Aurivillius in 1882. Excellent arguments can be found for each of these possibilities, and the name of the Cuban insect would be different in each case. If the first is followed, the Cuban choromorph becomes *Ascia monuste monuste;* the second, *Pieris phileta phileta;* the third, *Ascia monuste phileta.* From our point of view it seems best to reject the name *Papilio monuste* as of uncertain application in the American fauna, and to apply the next available name, *Papilio phileta* Fabricius.

The name *phileta* applies, strictly, to very dark females common in the Southern United States. A glance at a series of this butterfly from various parts of Middle America would seem to indicate the existence of several distinct choromorphs, but a careful study of the several hundred specimens from this area in the M.C.Z. fails to substantiate any such division. Specimens from Florida, Cuba, the Bahamas, St. Thomas, Lower California and Honduras show no choromorph differences in the male genitalia, although some of the South American forms do show such differences. Perhaps *P. phileta virginia* from Jamaica, Hispaniola, Puerto Rico and the Virgin Islands deserves separation, but specimens from the Bahamas and Florida often show the deep yellow color of the under side of the hindwing supposedly characteristic of *virginia.* The butterfly is a great migrant, and it is difficult to be sure that a uniform set of specimens from a given locality does not simply indicate a temporary "pure line," or a local or seasonal phenotype. I can certainly find no basis for the recognition of more than one choromorph in the Florida-Bahamas-Cuba area, and it is to this that the name *phileta* seems to apply.

The generic name *Ascia* Scopoli seems to depend directly on the Linnean name *monuste*, as Scopoli proposed the genus purely on a basis of the Linnean descriptions of the species he included. Scudder's designation of *monuste* as the genotype of *Ascia* is valid. If *monuste* is identical with *Picris cycnis* Hewitson, *Ascia* must replace *Belenois* or *Udaina*, depending on how those genera are defined. The generic name *Pieris* is used here, in a rather wide sense, as the best way out of the further problems that arise when we consider the possible other names, *Mancipium* of Hübner and *Ganyra* of Dalman.

Met. Gundlach lists the larva from cabbage (*Brassica*), *Cleome* and *Tropaeolum*.

Dist. In the M.C.Z. there are 100 specimens from Oriente, Sta. Clara (Soledad) and Habana.

15. Pieris menciae

Pieris menciae Ramsden, 1915, p. 15.
Ascia menciae: Talbot, 1932, p. 212.

The male of this species is pure white, except that the apex of the forewing is very faintly edged with black. It can easily be distinguished from any other Cuban butterfly by the chalky-white modified scales that margin the veins on the discal part of the wings above. Below, the apex of the forewing and the entire hindwing is "ivory yellow." The female is similar to the male, but lacks the sex scaling on the veins. Length of f.w., 30–32 mm.

Dist. I have seen only the types, which are in the A.N.S.P., from Guantanamo. This species may be the Cuban representative of the continental *P. sevata;* I have not been able to compare specimens of the two forms.

Genus III. Appias Hübner

Genotype, *Papilio zelmira* Cramer.

Röber in Seitz (p. 105, pl. 25c, 1909) described a species from Cuba as *Appias peregrina;* Hall (1925, p. 163) subsequently reported the species from Hispaniola. I have seen nothing like it in the Cuban material examined, and the localities in Seitz are very unreliable, so the name has been listed here as "doubtful."

16. Appias ilaire poeyi

Pieris ilaire: Poey, 1832, no. 12, 3 figs.; *id.*, 1846, p. 297; Herrich-Schäffer, 1864, p. 168.
Appias poeyi Butler, 1872, p. 49.
Pieris poeyi: Gundlach, 1881, p. 103.
Appias drusilla poeyi: Röber in Seitz, V, p. 68 (1909).
Tachyris ilaire: Holland, 1916, p. 496.
Melete ilaire form *neumoegeni:* Holland, 1931, p. 277, pl. 35, f. 5.
Andropodum drusilla molpadia: Talbot, 1932, p. 185.

The male is pure white above except for a fine dark border on the forewing, and some black scaling toward the base of the costa of this wing. Beneath, the hindwing and the tip of the forewing are slightly yellowish, and both wings are touched with orange at the base. The female is much darker, with heavy wing borders. Sometimes both the fore- and hindwing are bordered with black, sometimes only the forewing. The hindwing is yellowish above, pearly white below; the base of the forewing is orange below. Specimens of this sex are quite variable. Length of f.w., 24–30 mm.

Dist. The choromorph *poeyi* seems to be limited to Florida, the Bahamas, Cuba and Hispaniola, other forms occurring in Jamaica, Central and South America. In the M.C.Z. there are 24 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Genus IV. Melete Swainson

Genotype, *Papilio lycimnia* Cramer.
Daptonoura Butler, genotype, *Papilio lycimnia* Cramer.

17. *Melete salacia*

Fig. 4, venation; 5, profile of head.

Pieris salacia Godart, 1819, p. 144; Boisduval, 1836, p. 489; Poey, 1846, p. 299; Herrich-Schäffer, 1864b, p. 168.
Daptonoura salacia: Gundlach, 1881, p. 105.
Melete lycimnia cubana Fruhstorfer, 1908, p. 171.
Daptonoura salacia cubana: Röber in Seitz, V, p. 77 (1909).
Melete salacia cubana: Talbot, 1932, p. 56.

The male is white above, the apex of the forewing tipped with black. Beneath, the forewing is white, marked with orange basally, while the hindwing is yellowish; the apex of the forewing, a spot at the tip of the

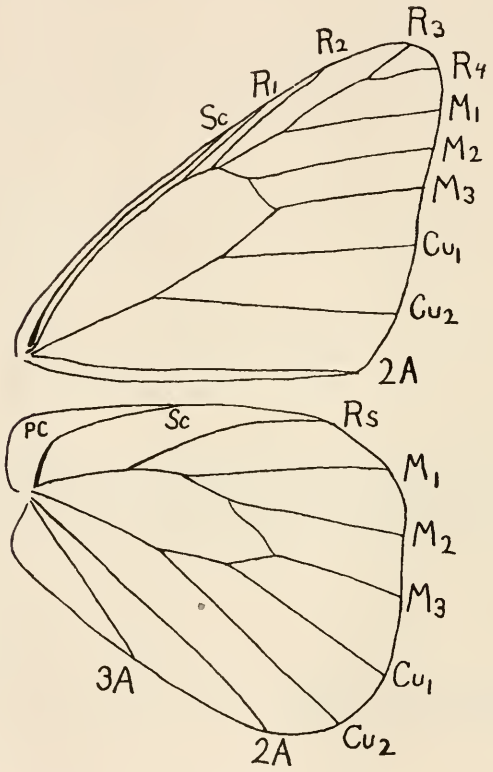

Fig. 4. *Melete salacia*, venation.

cell of this wing, and the outer margin of the hindwing, are black; the characteristic line across the disc of the hindwing is mentioned in the key. The female is similar, but more heavily marked. Length of f.w., 24–28 mm.

Godart described this species without locality, but Hispaniola may be presumed to have been the source of his specimens, as most of his West Indian material came from that island. The locality "Mexico"

sometimes quoted seems to be an error. I have not been able to compare Cuban and Hispaniolan specimens; if the two populations are distinct, Fruhstorfer's name is available for the Cuban form.

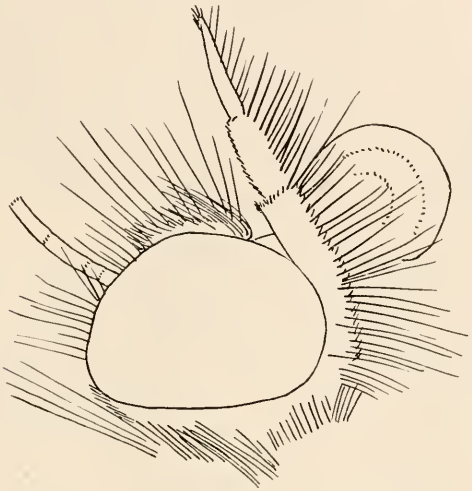

Fig. 5. *Melete salacia*, profile of head.

Met. Gundlach found the larvae on "roble-guayo" (*Petitia*). Fairchild and I found it feeding on a mistletoe, *Phoradendron Randiae*, at Soledad.

Dist. This species occurs everywhere in Cuba, according to Gundlach; there are 34 specimens in the M.C.Z. from Oriente and Sta. Clara (Soledad).

Genus V. Eurema Hübner

Genotype, *Pieris daira* Godart.
Terias Swainson, genotype *Papilio hecabe* Linn.

The American species of this genus have lately been reviewed by Klots (1928, 1929). The Cuban species are, for the most part, easily distinguished, although they present several as yet unsolved taxonomic problems.

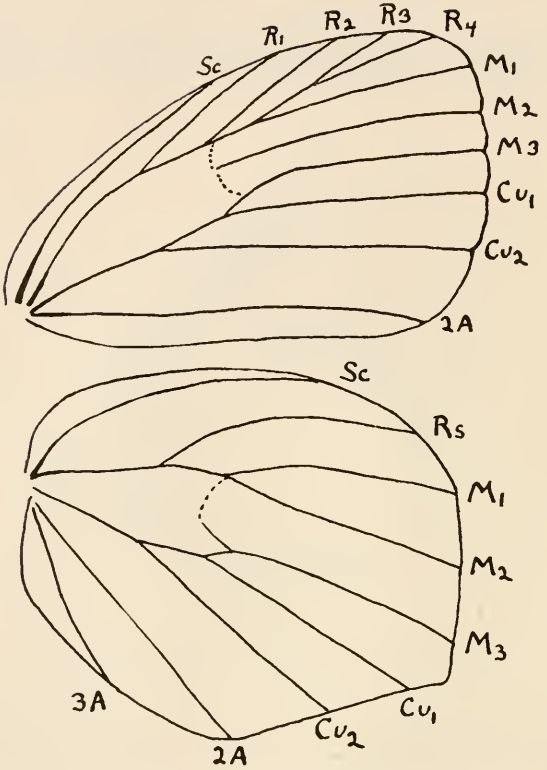

Fig. 6. *Eurema proterpia proterpia*, venation

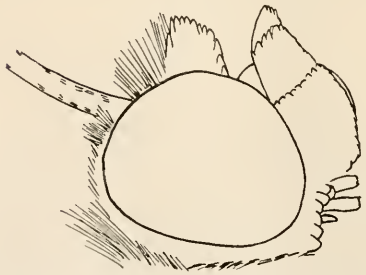

Fig. 7. *Eurema lisa*, profile of head.

Key to species

1. Ground color of upper side of h.w. white.....2
   Ground color of upper side of h.w. yellow or orange.....10
2. F.w. with a black bar on the inner margin above.....3
   No such bar.....5
3. Ground color of upper side of f.w. white.....18. *E. lucina* ♂
   Ground color of upper side of f.w. yellow.....4
4. No grey hairs in the black bar on the inner margin of f.w., or these hairs limited to the base.....20. *E. clathea* ♂
   This bar includes a few scattered grey hairs for its entire length. 19. *E. palmira* ♂
5. The apical black patch of f.w. extends along the outer margin to the inner angle; the narrow outer border of h.w. is complete (except in ♀ *E. amelia,* where it is lacking).....6
   The apical black patch of f.w. is cut off at Cu_2 or above, not reaching the inner margin; the border of h.w. is usually incomplete or interrupted.....7
6. Both wings with black dots at the end of the cell...24. *E. amelia*
   No such dots.....21. *E. messalina* ♂
7. F.w. with a small but distinct black dot at the end of the cell above. some ♀♀ of 28. *E. lisa*
   No discocellular spot.....8
8. Under side of h.w. with a distinct pink patch at the outer angle. 21. *E. messalina* ♀
   No such patch.....9
9. Under side of f.w. with a black bar at the end of the cell. 18. *E. lucina*
   No markings at end of cell, or two separated dots. 19. *E. palmira* ♀
10. Ground color of f.w. orange.....11
    Ground color of f.w. yellow.....14
11. Upper side of h.w. with a heavy black border; a black spot at the tip of the cell of f.w. above.....22. *E. nicippe*
    Border of h.w. narrow and indistinct, or represented by black dashes on the veins; no spot at end of cell of f.w.....12
12. Outer margin of h.w. evenly rounded.....29. *E. dina*
    Outer margin of h.w. angled or toothed between veins M_3 and Cu_1 (Fig. 6).....13

13. Under side of h.w. immaculate yellow, or with only a few isolated patches of brown scales.....25. *E. proterpia*
    Under side of h.w. with a heavy reticulate pattern of brown and reddish over the whole surface.....26. *E. gundlachia*
14. H.w. distinctly angled at vein Cu_1.....23. *E. boisduvaliana*
    H.w. with outer margin rounded.....15
15. Outer margin of h.w. tinged with orange above; marginal band of this wing either a thin uniform line (♂), or represented only by minute spots on the vein endings, or absent (♀)..29. *E. dina*
    H.w. uniform yellow, with a well developed marginal band on the upper part of the outer margin at least.....16
16. Fringe of wings pink; a small black dot at end of cell of f.w. above. 28. *E. lisa*
    Fringe of wings yellow; no cell spot.....27. *E. nise*

18. Eurema lucina

Terias lucina Poey, 1853, p. 252, pl. 18, f. 8, 9, 10; Herrich-Schäffer, 1864b, p. 167; Holland, 1916, p. 499.
Terias fornsi Poey, 1854b, p. 443.
Terias arabella Lucas, 1857, p. 515, pl. 16, f. 5, 5a.
Terias conjungens Herrich-Schäffer, 1864b, p. 167.
Eurema lucina: Gundlach, 1881, p. 95; Klots, 1929, p. 123, pl. I, f. 1, 2.
Eurema fornsi: Gundlach, 1881, p. 96.
Eurema conjungens: Gundlach, 1881, p. 97.
Eurema priddyi forbesi Klots, 1929, p. 124, pl. I, f. 4, 5a, 5b.

This species may be distinguished from the other Cuban *Eurema*s by the white ground color, suffused with green on the under side of the hindwing (winter form) or with some green spots (summer form). The male usually has a black bar on the inner margin of the forewing above. The only species with which it is liable to be confused is *E. amelia*. In *amelia* there is a black spot at the end of the cell of the forewing above, absent in *lucina;* the cell spot on the under side of this wing is double in *amelia*, a single bar in *lucina;* other differences are pointed out in the key. Length of f.w., 13–17 mm.

The names listed in the synonymy above seem all to apply to this species. The black marginal border of the hindwing may extend to Cu_2 (*fornsi*) or only to M_3 (*lucina*), or it may be intermediate; the hindwing may be completely suffused with greenish yellow beneath (*forbesi*), or it may be white with green patches (*lucina*)—apparently a seasonal

difference, as in the related *daira*. The bar of the male may be well developed, partially developed, or absent (*forbesi*), a condition found also in the Cuban *clathea*. Specimens in the M.C.Z. dated September, December and February correspond closely to *forbesi*; others from the same localities dated April, May and August correspond to *lucina*, with some spring and fall intermediates. The genitalia of several specimens examined seemed to be identical, and to differ constantly from either *daira* or *clathea*.

Dist. E. lucina is known only from Cuba; the Hispaniolan *priddyi*, with a yellow ground color, may be a choromorph of the same species. In the M.C.Z. there are 18 specimens from Sta. Clara (Soledad), Habana and the Isle of Pines; the U.S.N.M. has specimens from Oriente (Santiago), Habana, Pinar del Rio (paratype of *forbesi*) and the Isle of Pines. The A.M.N.H. paratype of *forbesi* is from the Isle of Pines.

19. Eurema daira palmira

Terias elathea: Poey, 1846, p. 385.
Terias albula: Poey, 1846, p. 385; *id.*, 1852, p. 198.
Terias palmira Poey, 1852, p. 198; *id.*, 1853, p. 249, pl. 24, f. 4, 5, 6; Herrich-Schäffer, 1864b, p. 165.
Terias ebriola Poey, 1853, p. 250, pl. 24, f. 7–13; Herrich-Schäffer, 1864b, p. 165.
Terias albina Poey, 1853, p. 251, pl. 24, f. 14, 15, 16.
Terias cubana Herrich-Schäffer, 1864b, p. 166.
Eurema cubana: Gundlach, 1881, p. 90.
Eurema palmira: Gundlach, 1881, p. 92.
Eurema jucunda: Gundlach, 1881, p. 94.
Eurema albina: Gundlach, 1881, p. 95.
Eurema palmyra: Klots, 1929, p. 126, pl. I, f. 11.
Eurema daira ebriola: Klots, 1929, p. 126, pl. 1, f. 19a, 19b, 20.

The long series of this species in the M.C.Z. shows a nice seasonal correspondence between *palmira*, with the hindwing white below (summer form) and *ebriola*, with this wing suffused with pink or brown (winter form). There is some mixture in November, which is to be expected if the color of the adult is due to the humidity or other factors in the micro-climate of the larva or pupa. *E. elathea* is the only species with which it is liable to be confused. Length of f.w., 13–17 mm.

Met. Gundlach found the larva on "amor seco" (*Desmodium*).

Dist. This species is said to occur almost everywhere in tropical America, but the choromorph *palmira* may be limited to Cuba.

Specimens from Hispaniola in the M.C.Z. differ only slightly from the Cuban ones; I have seen no Jamaican specimens. There are 359 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Oriente, Matanzas and the Isle of Pines.

20. Eurema elathea

Papilio elathea Cramer, Pap. Ex., 2, pl. 99, f. C, D. (1777).
Terias elathea: Herrich-Schäffer, 1864b, p. 166; Holland, 1916, p. 499.
Eurema elathea: Gundlach, 1881, p. 91; Klots, 1929, p. 128, pl. 1, f. 21, 22a, 22b.

There is considerable confusion in the application of this name, so that it is difficult to be sure of the synonymy. In the male sex, it is easily distinguished from *palmira* by the pure black of the bar on the inner margin of the forewing, which includes at most only a few grey hairs at the base. This bar may be very well developed, reduced, or absent, while in the several hundred males of *palmira* examined it is always present. The females are more difficult to distinguish. The apical black patch of the forewing extends to the outer angle in *elathea*, whereas in *palmira* it is abruptly cut off at vein Cu_2; the marginal border of the hindwing is also more complete in *elathea*. The few dated Cuban specimens that I have seen were caught in December and February. The December males have the under side of the hindwing irrorated with brown scales, while the February ones are almost white. Length of f.w., 13–16 mm.

Dist. The A.N.S.P. has ten specimens of this species from Oriente (Guantanamo), which they kindly lent me for study. Jamaican specimens are more common in collections. The species ranges widely in tropical America, but Klots (1929) found that it had not formed any well-marked geographical varieties.

21. Eurema messalina messalina

Papilio messalina Fabricius, 1787, p. 22.
Terias bulaea: Poey, 1853, p. 253; Herrich-Schäffer, 1864b, p. 168.
Terias iradia Poey, 1853, [p. 253], pl. 18, f. 14–17 [1852].
Terias gnathene: Lucas, 1857, p. 512, pl. 16, f. 3, 3a.
Eurema messalina: Gundlach, 1881, p. 98; Klots, 1929, p. 131, pl. 2, f. 41, 42a, 42b.

The sexes of this little insect are very different. The male is pure white above, except for the black border; the hindwing below is more

yellowish, as is the forewing along the costa and at the apex. There are some traces of pink on the hindwing below. The female has only the apex of the forewing and a spot on the outer margin of the hindwing black above; below, the large pink spot on the hindwing is very characteristic. The species shows an astonishing variation in size, the length of the forewing varying from 10 to 18 mm. in our series.

Met. The larva is similar to that of *palmira*, and lives on the same plant (*Desmodium*), according to Gundlach.

Dist. This species is said to occur in the West Indies, Yucatan and Florida. The Bahaman race, characterized by the reduced markings of the female, was named *blakei* by Maynard; the species seems to be quite constant on the other islands. In the M.C.Z. there are 78 specimens from Oriente, Sta. Clara (Soledad) and Habana.

22. Eurema nicippe

Papilio nicippe Cramer, Pap. Ex., 3, p. 31, pl. 210, f. C, D, (1779).
Terias nicippe: Poey, 1846, p. 383; *id.*, 1853, p. 245; Herrich-Schäffer, 1864b, p. 165; Röber in Seitz, V, p. 81, pl. 24a (1910); Holland, 1916, p. 498.
Eurema nicippe: Gundlach, 1881, p. 82; Klots, 1929, p. 132, pl. 2, f. 36a, 36b, 37; Holland, 1931, p. 301, pl. 37, f. 3–6.

The upper side is orange, broadly bordered with black on both wings. In the female, the orange of the discal area encroaches on the border of the hindwing, making its inner edge indefinite. The under side is lighter, marked with brown on the hindwing. There is a dark spot at the end of the cell of the forewing on both surfaces. Length of f.w., 18–25 mm.

Met. The larva, which lives on *Cassia*, has often been described.

Dist. This is a very common insect over much of the middle American region, occurring quite far north in the United States. In the M.C.Z. there are 76 specimens from Oriente, Sta. Clara (Soledad) and Habana. Specimens from Jamaica and Hispaniola do not seem to differ from those found in Cuba and the United States.

23. Eurema boisduvaliana

Terias boisduvaliana Felder & Felder, Reise Nov., p. 200 (1867).
Eurema boisduvaliana: Klots, 1929, p. 133, pl. 2, f. 51, 52.

This is a Central American species, not previously reported from Cuba. The ground color is yellow, with a heavy black border on both

wings in the male, limited to the apex of the forewing and absent or only partially developed on the hindwing in the female. The under side is almost immaculate yellow in all of our Cuban specimens. Length of f.w., 17–21 mm.

Dist. In the M.C.Z. there are 15 specimens from the vicinity of Central Soledad (Santa Clara).

24. Eurema amelia

Terias amelia Poey, 1853, p. 253, pl. 18, f. 11, 12, 13, [1852]; Herrich-Schäffer, 1864b, p. 168; Holland, 1916, p. 499.
Eurema amelia: Gundlach, 1881, p. 98; Klots, 1929, p. 136, pl. 2, f. 33.

The ground color of both wings is white. There is a rather heavy black apical patch on the forewing, that extends along the outer margin to the inner angle. The outer margin of the hindwing is completely but narrowly bordered with black in the male, but not in the female. Below, the costal and apical areas of the forewing and the entire hindwing are yellowish, with scattered dark scales. Length of f.w., 14 mm.

Dist. This species, known only from Cuba, was found in the savannahs near the Cienaga de Zapata (Sta. Clara) by Gundlach. The U.S.N.M. has a short series from the Isle of Pines and Pinar del Rio; Dr. Schaus kindly gave two of these specimens to the M.C.Z.

25. Eurema proterpia proterpia

Fig. 6, venation

Papilio proterpia Fabricius, 1775, p. 478.
Terias proterpia: Poey, 1846, p. 384; *id.,* 1853, p. 245; Herrich-Schäffer, 1864b, p. 165; Röber in Seitz, V, p. 81, pl. 24a, (1910).
Eurema proterpia: Gundlach, 1881, p. 84; Klots, 1929, p. 137, pl. 3, f. 68, 69; Holland, 1931, p. 301, pl. 37, f. 2.

This species is very similar to the following one; it may be distinguished by the character used in the key, and by the fact that the hindwing is very strongly angled between veins Cu_1 and M_3, but not tailed, as in *gundlachia.* The sexes are somewhat different: the ground color is deeper orange in the male than in the female, the black border at the apex of the forewing above is more rounded within, and so forth. The ends of the veins are often outlined in black, especially in the male. Length of f.w., 2–25 mm.

Dist. Klots (1929) recognized only two choromorphs in this species: the typical form ranging widely over Middle America, and the subspecies *watsonia* from Ecuador. The type locality of *proterpia* is Jamaica. In the M.C.Z. there are 24 specimens from Oriente and Sta. Clara (Soledad).

26. Eurema gundlachia

Terias gundlachia Poey, 1853, p. 246, pl. 24, f. 1, 2, 3; Herrich-Schäffer, 1864b, p. 165; Röber in Seitz, V, p. 81, pl. 24a (1910).
Eurema gundlachia: Gundlach, 1881, p. 85; Klots, 1929, p. 137, pl. 3, f. 72, 73; Holland, 1931, p. 300, pl. 73, f. 25.

This species is very similar to *proterpia*, but with the hindwing prominently toothed between Cu_2 and M_3, the veins not so extensively outlined in black above, and the under side of the hindwing heavily reticulated with reddish and brown lines and spots. Length of f.w., 22–23 mm.

Dist. The range of this form coincides, apparently, with that of *proterpia*, and I suspect that it is only a well marked phenotypic variety of that species. There are three specimens in the M.C.Z. from Oriente (Sierra Maestra, 1000 ft., Querci) and "Cuba;" Gundlach reports it from "western Cuba."

27. Eurema nise

Papilio nise Cramer, Pap. Ex., 1, p. 31, pl. 20, f. K, L. (1775).
Eurema nise perimede: Klots, 1929, p. 140, pl. 4, f. 92b, 93a, 93b, 94.

This Central American species, like *boisduvaliana*, seems not previously to have been reported from Cuba. We found it to be rather abundant in the vicinity of Central Soledad, flying in company with the similar *E. lisa*. It is not likely to be confused with any other Cuban species unless it be *lisa*, from which it may be separated by the yellow fringe of the wings, and the reduced markings of the hindwing below—clear yellow in the male, marked lightly with brown in the female. Length of f.w., 14–18 mm.

Dist. This species ranges widely in tropical America, and Klots (1929) found that it had formed several geographical races. The nomenclature that he used for these forms, however, seems very uncertain, and with only limited material for comparison, I have been unable to check his arrangement. He applies, for instance, the name

perimede, based on a Brazilian specimen, to the Central American choromorph! Cramer's *nise* is said to have come from Jamaica, but as no such form is now known from that island, the type locality of the name must be considered doubtful. Godman and Salvin (Biologia, 2, p. 165) rejected the name *nise* entirely, and called this species *Terias tenella* Boisduval: also a Brazilian name. Cuban specimens seem to be identical with specimens from Honduras. In the M.C.Z. there are 15 specimens from Sta. Clara (Soledad); the A.M.N.H. has a specimen from Habana.

28. Eurema lisa

Fig. 7, profile of head

Xanthidia lisa Boisduval & Leconte, 1833, p. 53, pl. 19, f. 4, 5.
Terias sulphurina Poey, 1853, p. 248, pl. 18, f. 1, 2, 3, [1852].
Terias lisa sulphurina: Herrich-Schäffer, 1864b, p. 168.
Eurema lisa: Gundlach, 1881, p. 89; Klots, 1929, p. 138, pl. 3, f. 74, 75; Holland, 1931, p. 302, pl. 37, f. 13.
Terias lisa: Röber in Seitz, V, p. 83, pl. 24d (1910).
Terias euterpe: Holland, 1916, p. 499.

The females of this species are much lighter than the males, often quite white, and they have the marginal band of the hindwing less completely developed. The pink spot on the under side of the hindwing, between veins R and M_1 is characteristic. Length of f.w., 12–17 mm.

Met. The larva has often been described by entomologists in the United States; it lives on various species of *Cassia*.

Dist. *E. lisa* has a wide range in North and Middle America, but it seems not to have formed distinct choromorphs. In the M.C.Z. there are 256 specimens from Oriente, Sta. Clara (Soledad) and Habana.

29. Eurema dina dina

Terias dina Poey, 1832, no. 11, 2 figs.; *id.*, 1846, p. 384; *id.*, 1852, p. 197; *id.*, 1853, p. 247; Herrich-Schäffer, 1864b, p. 167; Holland, 1916, p. 498.
Terias citrina Poey, 1853, p. 247, pl. 18, f. 4–7, [1852]; Herrich-Schäffer, 1864b, p. 167; Holland, 1916, p. 498.
Terias larae Herrich-Schäffer, 1862, p. 120; *id.*, 1864b, p. 167.
Eurema dina: Gundlach, 1881, p. 86; Klots, 1929, p. 139, pl. 3, f. 79, 80.
Eurema citrina: Gundlach, 1881, p. 87.
Eurema larae: Gundlach, 1881, p. 88.

The forewing above varies from yellow to orange, margined completely, but rather narrowly, with black; the hindwing is orange, or yellow tending to orange on the outer margin, with a fine black border that may be reduced or absent. The wings beneath are yellow, with a small black discal dot on the forewing, and with two such dots on the hindwing. Length of f.w., 18–23 mm.

Dist. This species is made up of several choromorphs, and the complex thus formed has a wide range in tropical America. *Dina, s.s.* seems to be limited to Cuba and Hispaniola. In the M.C.Z. there are 94 specimens from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Oriente and Pinar del Rio.

Genus VI. Phoebis Hübner

Genotype, *Papilio argante* Fabricius.

Forbes (1927) has recently published a key to the American species of *Phoebis* (*Catopsilia*), and Brown (1929, 1931) has reviewed the group in some detail, basing his study largely on the male genitalia. Klots (1933, p. 181) is probably correct, from the phylogenetic point of view, in separating the American forms, as *Phoebis*, from the Old World *Catopsilias;* further subdivision, however, seems unwarranted.

The nomenclature and classification of the forms of this group have long been very confused. No recent student of the genus has attempted to unravel the complicated bibliographies of the various species, and none has made a thorough study of type specimens. The sexual and individual dimorphism of many species has made their study difficult, and has overshadowed the more important problem, from our point of view, of geographical variation. It has, as a result, been very difficult to be sure of the nomenclature of the Cuban forms, and the names adopted here are very uncertain in several cases.

It is possible that some form of *P. editha* or of *P. trite* will be found in Cuba, in addition to the species listed here. For a discussion of the Hispaniolan *P. editha* see the paper by Brown (1933, p. 3).

Key to species

1. F.w. above with a black or dark brown spot at the end of the cell (usually females) 7
   No such spot (males) 2

2. Wings above entirely yellow; marked below with a few fine brown spots and lines . . . . . 30. *P. sennae* ♂
   Wings orange or yellow and white, or if yellow, with the under side immaculate 3
3. Wings above orange 4
   Wings above white or yellow, in part at least 5
4. The reddish bar on the under side of f.w., which extends from about vein Cu_2 to R_4 is entire, straight . . . . . 34. *P. agarithe* ♂
   This bar is interrupted in the middle, becoming a somewhat zig-zag series of spots . . . . . 33. *P. argante* ♂
5. Base of f.w. with a large round orange spot, surrounded by some yellow; outer half of wing white . . . . . 37. *P. orbis* ♂
   Base of f.w. lemon yellow above, not marked with orange 6
6. Mealy border on outer half of wings above white, or at least contrasting with the yellow basal area; this outer mealy area enters, or touches, the tip of the cell of f.w. . . . 35. *P. statira* ♂
   Mealy border of wings yellow, like the basal area; this border lies entirely outside of the cell of f.w. . . . . 36. *P. neleis* ♂
7. Disc of f.w. above with a large contrasting patch of color, orange or red, which extends from the inner margin into the cell 8
   No such area 9
8. Patch on f.w. red; h.w. extensively shaded with red. 32. *P. avellaneda* ♂
   This patch orange, as is the shading on h.w. . . . . 31. *P. philea* ♂
9. Postmedian row of spots on under side of f.w. not distinct below Cu_1, never extending below Cu_2 10
   One spot at least of this row below Cu_2 12
10. Ground color of wings above orange . . . . . 37. *P. orbis* ♀
    Ground color light yellow, or almost white 11
11. Outer margin of f.w. above with a narrow black border. 35. *P. statira* ♀
    This border represented only by small, disconnected spots. 36. *P. neleis* ♀
12. Large species (f.w. usually more than 40 mm. long), with a complete row of postmedian spots on f.w. above 13
    Smaller species (f.w. usually less than 35 mm. long), with the postmedian spots either absent above, obsolescent, or not distinct below Cu_1 14

13. Under side of h.w. heavily dusted with reddish, with almost no pattern apparent .....32. *P. avellaneda* ♀
    Under surface of h.w. deep yellow, with a heavy purplish border and some purple spots.....31. *P. philea* ♀
14. Postmedian row of spots on f.w. below forming an even line from the inner margin toward the apex (as couplet 4).
    34. *P. agarithe* ♀
    This line of spots interrupted, zig-zag.....15
15. The postmedian spots of f.w. above remain distinct from the dark border of the apex of the wing.....30. *P. sennae* ♀
    These spots merge with a dark patch at the apex of the wing.
    33. *P. argante* ♀

30. Phoebis sennae sennae

Papilio sennae Linnaeus, 1758, p. 470.
Callidryas eubule: Poey, 1846, p. 300; Herrich-Schäffer, 1864b, p. 169; Holland, 1931, p. 289, pl. 33, f. 2, 3.
Catopsilia eubule: Gundlach, 1881, p. 115; Röber in Seitz, V, p. 85, pl. 25a; Holland, 1916, p. 496.
Phoebis eubule sennae: Brown, 1929, p. 7, f. 8–10 (genit.).
Phoebis eubule sennae f. ♀ *sennalba* Brown, 1929, p. 8.

This is an exceedingly common insect in Cuba. It is very variable in the female sex, but the character given in the key (couplet 15) seems always to distinguish it from related species. Length of f.w., 30–35 mm.

Met. The larva, often described, lives on various species of *Cassia*.

Dist. Brown (1929) recognized four choromorphs in this species: *eubule* from the United States; *sennae* from the West Indies, *marcellina* from the tropical mainland, and *amphitrite* from the South Temperate region. He stated (p. 7) that "Linnaeus' type [of *sennae*] was from Jamaica," and we may consider this as a type restriction. Linnaeus included three references under *sennae*, one to Sloan, one to Ray and one to Merian. Both the Sloan and Ray references are to Jamaica, so that by precedence, majority rule, or type restriction, Jamaica wins as the type locality. The name *sennae* has several years priority over *eubule* (*Papilio eubule* Linn., 1767, p. 764), so that it must form the species name.

There are 76 specimens in the M.C.Z. from Oriente, Camagüey, Sta. Clara (Soledad) and Habana.

31. Phoebis philea thalestris

Papilio Danaus Thalestris Illiger, 1801, p. 207
Colias thalestris: Hübner, Ex. Schm., 2, pl. 133, f. 1, 2.
Callidryas thalestris: Poey, 1846, p. 299; Herrich-Schäffer, 1864b, p. 169; Butler, Lep. Ex., p. 93, pl. 35, f. 5–8 (1872).
Catopsilia thalestris: Gundlach, 1881, p. 107; *id.*, 1891, p. 449.
Catopsilia philea thalestris: Röber in Seitz, V, p. 86 (1910).
Phoebis philea thalestris: Brown, 1929, p. 11.

The male is yellow above, with a black spot at the end of the cell of the forewing, and with a large orange patch over the discal area; the hindwing is yellow, washed with orange on the outer margin. The female is a very different looking insect: dull orange, dusted with reddish above, and with heavy brown markings. Length of f.w., 42–48 mm.

Met. Gundlach described the early stages of this species in some detail. He found the larva on "Guacamaya colorada" (*Poinciana pulcherrima*), "Caña fístola" (*Cassia fistula, grandis*) and "Yerba hedionda" (*Cassia occidentalis*).

Dist. P. philea ranges widely in tropical America, but the choromorph *thalestris* is limited to Cuba and Hispaniola. There are only two specimens from Cuba in the M.C.Z., both from Oriente (Sierra Maestra, 1000 ft., Querci; "Cuba, Wright"). The U.S.N.M. has nine specimens from Oriente (Tagua, Alto del Cedro).

32. Phoebis avellaneda

Callidryas thalestris var.: Herrich-Schäffer, 1862, p. 119.
Callidryas avellaneda Herrich-Schäffer, 1864b, p. 169; Butler, Lep. Ex., p. 95, pl. 36, f. 3, 4, 5 (1872).
Callidryas solstitia Butler, 1869b, p. 203; *id.*, Lep. Ex., p. 95, pl. 36, f. 1, 2.
Catopsilia avellaneda: Gundlach, 1881, p. 109; Röber in Seitz, V, p. 86, pl. 25d (1910).
Phoebis avellaneda: Brown, 1929, p. 11, f. 17–19 (genit.).

The bright red of the male of this species will distinguish it from any other American Pierid. The female is quite similar to that of *thalestris*, and the two may be most easily separated by the character used in the key. Length of f.w., 40–45 mm.

Dist. This species is known only from Cuba and Hispaniola. There are three males in the M.C.Z. from Oriente (Santiago de Cuba) and

Sta. Clara (Soledad). The U.S.N.M. has a beautiful series from Santiago de Cuba.

33. Phoebis argante rorata

Callidryas argante: Herrich-Schäffer, 1864b, p. 169.
Callidryas rorata Butler, 1869b, p. 202; *id.*, Lep. Ex., p. 118, pl. 44, f. 5–8 (1872).
Callidryas minuscula Butler, 1869c, p. 16; Lep. Ex., p. 120, pl. 44, f. 9, 10, 10a (1872).
Callidryas fornax Butler, 1871, p. 170; *id.*, Lep. Ex., p. 105, pl. 39, f. 5, 6 (1872).
Catopsilia argante: Gundlach, 1881, p. 111.
Phoebis argante rorata: Brown, 1929, p. 12.
Phoebis argante rorata form ♀ *adela* Brown, 1929, p. 13.

The male is similar to the male of *agarithe;* it is most easily distinguished by the interrupted course of the postmedian spots, described in the key. The female is rather variable, often very heavily marked. Length of f.w., 32–35 mm.

Met. Gundlach mentions that the larva feeds on various Caesalpineae, but he does not describe it.

Dist. Brown recognized two choromorphs of this species: the typical *argante* found almost everywhere on the tropical mainland, and *rorata,* known only from Cuba and Hispaniola. The only Cuban specimen in the M.C.Z. is a light-colored female from Oriente ("Cuba, Wright"). The U.S.N.M. specimens are from Matanzas and Oriente (Alto del Cedro). There is a very interesting female of this form in the Cornell University Collection, labelled "Cuba," with the outer half of the hindwing above brick-red, almost exactly like Butler's figure of *fornax.*

34. Phoebis agarithe agarithe

Colias agarithe Boisduval, 1836, p. 623.
Callidryas agarithe: Poey, 1846, p. 301; Lucas, 1857, p. 496, pl. 15, f. 4b, 4c (*part.*); Herrich-Schäffer, 1864b, p. 169; Butler, Lep. Ex., p. 121, pl. 45, f. 1–4 (1873); Holland, 1931, p. 289, pl. 33, f. 1, pl. 67, f. 19.
Catopsilia agarithe: Gundlach, 1881, p. 111.
?*Catopsilia agarithe fornax:* Holland, 1916, p. 497.
Phoebis agarithe antillia Brown, 1929, p. 15.

The male is a uniform bright orange above, somewhat lighter below, with various fine reddish-brown markings. The female is sometimes

quite similar to the male, sometimes lighter colored with heavier markings. The submedian spots of the forewing on the under side form a straight line in both sexes. Length of f.w., 32–35 mm.

Mct. The larva has been found on *Pithecolobium guadaloupensis* in Florida.

Dist. This species is found in all parts of Middle America, but it is usually common only near the coast, where its food plant grows. I have been unable to distinguish the choromorphs separated by Brown (1929), but as the series in the M.C.Z. includes only about 50 specimens, with many localities quite unrepresented, it is very possible that I have been misled. A short series from Lower California seems to represent a homogeneous and distinct race; otherwise I cannot separate Central American and West Indian specimens. Brown stated that "the race *antillia* is characterized by a great amount of Indian-red scaling on the under surface." I find that our Antillean specimens (Jamaica, Bahamas, Cuba) are generally more lightly marked than continental ones; sometimes they are almost immaculate. The difference may be seasonal, as most of our specimens were taken in the summer, while Brown's types were dated February and April. The name *agarithe*, which Brown applies to the "South American race," was based on Mexican specimens.

There is only a single pair of this species from Cuba in the M.C.Z.: from Santa Clara (Cienfuegos Bay, June, August.)

35. Phoebis statira jada

Callidryas evadne: Boisduval, 1836, p. 628 (*part.*).
Callidryas alcmeone: Poey, 1846, p. 300; *id.*, 1852, p. 197.
Callidryas jada Butler, 1870, p. 11.
Catopsilia statira: Gundlach, 1881, p. 118; *id.*, 1891, p. 449.
!*Catopsilia neleis:* Holland, 1916, p. 497.
!*Aphrissa statira neleis:* Brown, 1931, p. 9, f. 10–12 (genit.).

Probably the best way to collect this and the following species is to take all specimens of *sennae* seen, and examine them carefully before discarding them. The male is at once distinguishable by the light outer half of the wings above, covered with modified scales. The female is, however, apt to be confused with lightly marked females of *sennae* in the field. Probably it can be most quickly distinguished by a glance at the palpi, which have an elongate terminal joint in this (and the following ?) species, very different from the small knob found on *sennae* females. Length of f.w., 25–30 mm.

Met. Gundlach (1891) found the larva on "Guacamaya cimarrona," a species of *Cassia*.

Dist. P. statira ranges widely in the American tropics, and it is sufficiently variable to have accumulated an impressive synonymy. The Cuban form was separated by Brown (*l.c.*) largely on characters of the female, but as he did not recognize the true *neleis*, I suspect that his series of *statira* females was mixed. The M.C.Z. material is inadequate for a thorough study of the question, but I can find no characters by which our Cuban males or females can be separated from specimens from Honduras, Guatemala or Mexico. South American specimens, and the few specimens that we have from Central America south of Honduras, seem distinct, with a narrow black border on the forewing of the male, heavier markings on the female, and so forth. The only Florida specimen that I have seen is larger and yellower than our Cuban males. It has seemed to me best, then, to separate specimens from northern Central America and Cuba as *jada* Butler, using the oldest name available for this area. The name *zulema* Poey (1852, p. 198) is not available for the Cuban form, as it was published as a possible substitute name for *alcmeone* Fabricius, and is thus an absolute synonym of *evadne*, which in turn is a synonym of the South American *statira*. The choromorphs found on Hispaniola and Jamaica are quite distinct.

In the M.C.Z. there are six males and two females from Oriente, Sta. Clara (Soledad) and Habana.

36. Phoebis neleis

Callidryas neleis Boisduval, 1836, p. 629; Poey, 1846, p. 301; Lucas, 1857, p. 498, pl. 15, f. 5, 5a, 5b, 5c; Herrich-Schäffer, 1864b, p. 169; Butler, Lep. Ex., p. 145, pl. 52, f. 1–4 (1873).
Catopsilia neleis: Gundlach, 1881, p. 117.
?*Callidryas editha:* Holland, 1916, p. 498.
?*Callidryas statira neleis* f. ♀ *poeyae* Brown, 1931, p. 10.

The male of this species is larger than that of *C. statira*, and has the mealy outer half of the wings above yellow, like the ground color. I have not seen the female, but according to Gundlach, it may be distinguished by the character used in the key (reduced markings of forewing above), by the deeper yellow ground color, both above and on the under side of the hindwing, and by the fact that the under side of the forewing becomes slightly darker toward the inner margin, while it becomes lighter in *statira*. Length of f.w., 35 mm.

Dist. This species is known only from Cuba. The male genitalia are quite distinct from those of any other species known to me, but they show the same general structure as those of *godartiana*, judging by Brown's figures (1931, f. 4–6). The female form *poeyae* described by Brown may be this species.

There is one male in the M.C.Z. from Oriente ("Cuba, Wright") and I noticed several specimens in the A.N.S.P. from Guantanamo that may belong to this species.

37. Phoebis orbis

Callidryas orbis Poey, 1832, no. 1, 5 figs.; *id.*, 1846, p. 300; *id.*, 1852, p. 196; Butler, Lep. Ex., p. 153, pl. 55, f. 1–4 (1873).
Callidryas godartiana: Herrich-Schäffer, 1864b, p. 169.
Catopsilia orbis: Gundlach, 1881, p. 113; Röber in Seitz, V, p. 88, pl. 26a (1910).
Catopsilia drya: Holland, 1916, p. 497.
Aphrissa orbis: Brown, 1931, p. 4.

This species has been so often bred that there can no longer be any doubt as to the correct association of the sexes. The male is unique in having a curious orange disc at the base of the forewing above. The female is a uniform light orange, with the forewing rather heavily bordered with brown; it may be distinguished from its allies by the various characters given in the key. Length of f.w., 26–35 mm.

Met. The larva lives on "Guacamaya colorado" (*Poinciana pulcherrima*) according to Gundlach.

Dist. This species is known only from Cuba and Hispaniola. In the M.C.Z. there are 16 specimens from Oriente, Camagüey and Habana, many of them bred from Poinciana.

Genus VII. Anteos Hübner

Genotype, *Papilio maerula* Fabricius.

The two Cuban species may be distinguished thus:

1. Upper surface lemon yellow.....38. *A. maerula*
   Upper surface white, with a yellow or orange patch over the cell of f.w.....39. *A. clorinde*

38. Anteos maerula maerula

Papilio maerula Fabricus, 1775, p. 479.
Gonepteryx maerula: Herrich-Schäffer, 1862, p. 120; *id.*, 1864b, p. 169; Gundlach, 1881, p. 119; Röber in Seitz, V, p. 89, pl. 24g (1910).
Anteos maerula: Klots, 1929b, p. 140.

The upper surface of this species is a uniform lemon yellow, except for a black spot at the end of the cell of the forewing, and a similar, light brown, spot on the hindwing. The under side is faintly reticulated with yellow on a lighter background. The sexes are very similar. Length of f.w., 40–48 mm.

Met. Gundlach bred this species from a *Cassia* known as "Frijol de Gallina" in Santiago de Cuba.

Dist. Fabricius described this species from "America, mus. Hunter." As the Hunter collection included material from Jamaica, where this butterfly has long been known, we may provisionally consider that island as the type locality. The species has a wide range, and shows both individual and geographical variation in the shape of the wings, development of discal spots, ground color, reticulation of under surface, and so forth. The series in the M.C.Z. is too short to permit a careful analysis of this variation, but it would seem that the form *lacordairei* Boisduval from northern Central America is a good choromorph. Cuban specimens are very like those from Nicaragua, and it is probable that Jamaican and Hispaniolan specimens will be found to be similar.

In the M.C.Z. there are 5 specimens from Oriente (Sierra Maestra, 1000 ft., Querci).

39. Anteos clorinde nivifera

Rhodocera clorinde nivifera Fruhstorfer, 1907, p. 294.
Gonepteryx clorinde: Röber in Seitz, V, p. 89, pl. 24g; Holland, 1931, p. 290, pl. 71, f. 11.
Anteos clorinde: Klots, 1929b, p. 140.

This species seems not to have been reported from Cuba previously. Fairchild and I found it to be quite common in the vicinity of Soledad, where it was breeding on a large species of *Cassia* growing in waste places. It is a striking butterfly, white above, with a bright orange

patch over the end of the cell of the forewing in the male. In the female this patch is yellow and more diffuse, almost disappearing in some specimens. Length of f.w., 40–47 mm.

Dist. Godart described *clorinde* from Brazil (1819, p. 813); he stated that the cell patch of the male was "lemon yellow," and Godman and Salvin (Biologia, II, p. 149) remark that all South American specimens, almost without exception, have the orange spot of the forewing of a rather more lemon tint than Central American specimens. Cuban specimens seem not to differ from Central American ones, and consequently, although I have not been able to examine Brazilian males, I have used Fruhstorfer's name *nivifera*, which was based on specimens from Honduras.

In the M.C.Z. there are 9 specimens from Sta. Clara (Soledad).

Genus VIII. Kricogonia Reakirt

Genotype, *Colias lyside* Godart.

Specimens of this genus seem to be rather rare in collections, and many forms have been described the exact status of which is not known. Our longest series is from Texas and Arizona, and includes specimens that will fit almost any of the names so far proposed. The oldest name is *Papilio castalia* Fabricius (1793, p. 188), based on an unpublished Jones drawing; this has no locality, but the specimen presumably came from Jamaica. The next name, *lyside*, was also published without locality; the description fits Hispaniolan specimens, and as Godart received many butterflies from that island, it may provisionally be considered as the type locality. Our specimens from Hispaniola are similar to our Jamaican specimens, in that both lack the black bar on the hindwing above, but Geyer in Hübner (Zuträge, 5th Hundred, p. 13, f. 843, 844) figures a banded form from Port-au-Prince. The nomenclature and relationships of these various forms cannot be settled without a great deal of material from many localities. Two Cuban forms seem distinct enough to be called "species." They may be separated thus:

1. Under surface of h.w. with a reticulate pattern of somewhat greenish scales on an ivory ground color . . . . . 41. *K. cabrerai*

   This wing uniform lemon yellow, or sometimes with silvery patches. 40. *K. lyside*

40. Kricogonia lyside

Colias lyside Godart, 1819, p. 98.
Callidryas lyside: Poey, 1854b, p. 442, pl. 15, f. 5, 6, 7.
Gonopteryx lyside: Herrich-Schäffer, 1864b, p. 169.
Kricogonia lyside: Gundlach, 1881, p. 120: Röber in Seitz, V, p. 89 (1910).

The ground color varies from white to greenish yellow; the base of the forewing may be a contrasting orange or concolorous with the rest of the wing; there may or may not be a black bar on the hindwing above perpendicular to the costa. Length of f.w., 21 mm. (this may vary considerably).

Dist. The only specimen in the M.C.Z. (labelled "Cuba, Wright") is similar to Bahaman specimens, which seem to be uniformly smaller than those from Hispaniola and Jamaica. From the account of Gundlach, however, it would seem that the Cuban form is very variable; he states that it is not uncommon in the neighborhood of the coast.

41. Kricogonia cabrerai

Kricogonia cabrerai Ramsden, 1920, p. 259.

"This form is larger than any I have seen from any other locality. It differs from *terissa* [*lyside*], on the upperside, in having the black band longer and wider, extending in this form nearly to the middle of the wing, while in *terissa* it hardly extends to more than a quarter. The base of the primaries is not orange as in *terissa* and differs on the underside, by the marbled appearance of the secondaries." Length of f.w., 27 mm.

Dist. I have seen only the types, from Guantanamo (Oriente) in the A.N.S.P., and a male from Santiago de Cuba in the U.S.N.M.

Genus IX. Zerene Hübner

Genotype, *Papilio cesonia* Stoll.

42. Zerene cesonia cesonia

Papilio cesonia Stoll, 1790, p. 176, pl. 41, f. 2, 2b.
Colias cesonia: Poey, 1846, p. 302.
Colias caesonia: Herrich-Schäffer, 1864b, p. 169.
Meganostoma caesonia: Gundlach, 1881, p. 105; Röber in Seitz, V, p. 94, pl. 26f (1910).
Zerene caesonia: Holland, 1931, p. 292, pl. 36, f. 3, 4.

The "dog-face" pattern of the upper side of the forewings of this species—formed by the heavy black border, dark base, and prominent discocellular spot—is characteristic. Cuban specimens seem to show a wider range of variation that those from the southern United States and Central America, and in one of our specimens the black margin of the forewing has almost disappeared. Length of f.w., 28–32 mm.

Met. The larva feeds on *Trifolium* and *Amorpha* in the United States.

Dist. This species extends over most of North and Middle America, and along the Andes in South America. It does not seem to have formed any distinct choromorphs north of South America, unless the Hispaniolan *cynops* should prove to deserve that status. In the M.C.Z. there are 8 specimens from Habana; in the U.S.N.M. there is a specimen from Matanzas.

Genus X. Nathalis Boisduval

Genotype, *Nathalis iole* Boisduval.

43. Nathalis iole

Nathalis iole Boisduval, 1836, p. 589; Gundlach, 1881, p. 99; Röber in Seitz, V, p. 95, pl. 27h (1910); Holland, 1931, p. 283, pl. 32, f. 21, 22.

Nathalis felicia Poey, 1854b, p. 443, pl. 18, f. 18–21; Herrich-Schäffer, 1864b, p. 168.

The ground color of the male is yellow, of the female darker, tending to orange; the apex of the forewing is broadly black and there is a broad black bar along the inner margin of this wing above, and another, narrower, on the costal margin of the hindwing. Length of f.w., 10–15 mm.

Dist. This species ranges over most of Middle America; it was first described from Mexico. Cuban specimens are much more constant in pattern than North American ones, but I can find no difference that would justify the retention of the name *felicia*. There are 104 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana; there are specimens in the U.S.N.M. from Matanzas.

Genus XI. Dismorphia Hübner

Genotype, *Papilio laia* Cramer.

44. Dismorphia cubana

Fig. 8, venation

Leptalis cubana Herrich-Schäffer, 1862, p. 120.
Dismorphia cubana: Gundlach, 1881, p. 81; Röber in Seitz, V, p. 102, pl. 30b; Talbot, 1932, p. 18.

The forewing of the male is dark brown, with three yellow spots and a yellow bar on the apex, and an orange bar along the inner margin;

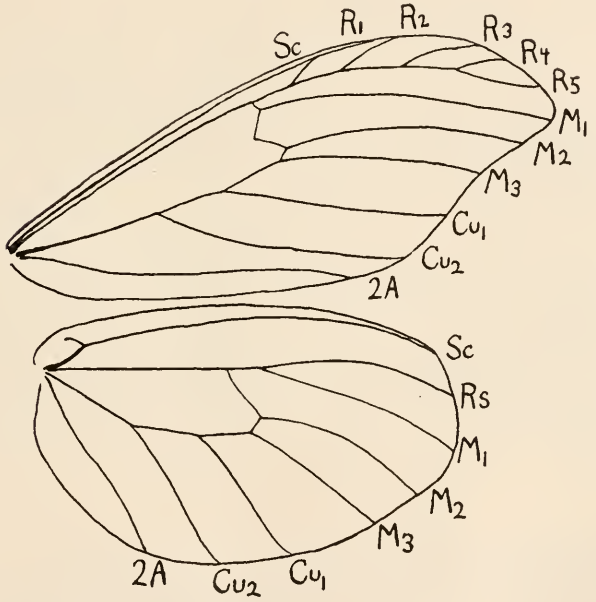

Fig. 8. *Dismorphia cubana*, venation.

the hindwing is orange, edged with dark brown. In the female, all of the markings are yellow. Length of f.w., 30 mm.

Dist. This species is known only from Cuba; there is, however, a similar species in Hispaniola. It is limited to the highest mountains, according to Gundlach. In the M.C.Z. there are four specimens from Oriente (Cuba, Wright); the U.S.N.M. has 7 specimens from Oriente (Baracoa, Rio Caño) and Pinar del Rio (San Diego de los Baños).

Family III. DANAIDAE

This group is sometimes made a subfamily of the Nymphalidae, with which it has much in common. It includes two sections: the first the Danaids proper, tropicopolitan, including only a few genera but many species and choromorphs; the second the Ithomiids, entirely Neotropical, with many genera and species of which only one (*Hymenitis*) reaches Cuba.

Key to genera

1. Basal joint of palpus elongate, almost as long as the second joint; wings almost entirely transparent. (Fig. 10, venation) XV. *Hymenitis*
   Basal joint of palpus much shorter than second joint; wings fully scaled, brown 2
2. Discocellular vein between M_3–Cu_1 of h.w. about as long as that between M_2–M_3; f.w. elongate ..... XIII. *Lycorea*
   Discocellular M_3–Cu_1 of h.w. much shorter than M_2–M_3; f.w. of normal shape 3
3. Antenna with a distinct, flattened club; under side of f.w. with markings across the cell—fine white or blue lines. (Fig. 9, venation.) ..... XIV. *Anelia*
   Antenna thickening gradually to tip, not flattened; cell of f.w. on under side uniform brown, except for peripheral spots and shadings ..... XII. *Danaus*

Genus XII. Danaus Kluk

Genotype, *Papilio plexippus* Linnaeus.

This generic name is used here on the authority of Hemming (1933, p. 222), as I have not seen the 1802 paper by Kluk in which it is supposed to have been published. If the Kluk reference, certainly very obscure, proves to be unavailable, the name *Danaida*, proposed by Latreille, must be used for the genus. It seems to me impossible to date the name *Danaus* from Linnaeus, who used it in the plural form *Danai* (see Scudder, 1875, p. 93).

It is quite possible that *D. erippus* or *D. cleophile* will eventually be found in Cuba; the first is very like *plexippus*, but without the black bar on the inner margin of the forewing, the second may be distinguished by the yellowish apical spots of the forewing.

Key to species

1. Inner margin of f.w. bordered with black.....45. *D. plexippus*
   This margin brown, concolorous with disc.....2
2. Veins of under side of h.w. outlined in black, bordered with white; no postdiscal row of spots on this wing below...46. *D. berenice*
   Veins of under side of h.w. not bordered with white; a row of large whitish postdiscal spots from costa to Cu_2 on this wing below. 47. *D. eresimus*

45. Danaus plexippus plexippus

Papilio plexippus Linnaeus, 1758, p. 471.
Papilio archippus Fabricius, 1793, p. 49.
Anosia megalippe Hübner, Ex. Schm., 2, pl. 7, 2 figs, (1819–26).
Danais erippus: Poey, 1847, p. 175; *id.*, 1852, p. 198; Gundlach, 1881, p. 23.
Danais archippus: Herrich-Schäffer, 1864b, p. 161; Haensch in Seitz, V, p. 113 (1909).
Danais plexippus: Holland, 1931, p. 68, pl. 7, f. 1.
Danaida archippus archippus: Hulstaert, 1931, p. 21.

The ground color is brown, with both wings completely bordered with black; the veins are outlined by black. The apex of the forewing above is almost entirely black in some specimens, and includes several white spots; the black border of the outer margin of both wings also includes two rows of white spots, sometimes only partly developed. The pattern of the upper surface is repeated on the under side, but the ground color of the hindwing is considerably lighter. Length of f.w., 40–50 mm.

The application of the Linnean name *plexippus* is somewhat uncertain, but it has been used here for this species as the most satisfactory way out of the various difficulties presented by the possible alternative names. Riley (1929, Trans. Ent. Soc. London, **76**, p. 454) has discussed the probable significance of *plexippus* at some length.

Met. The larva, which is well known, feeds on various species of *Asclepias* (Flor de Calentura).

Dist. Cuban specimens of this species, which is almost cosmopolitan, fall within the range of variation shown by the North American population. Specimens from other West Indian islands and from the tropical mainland have been separated as distinct choromorphs. In the M.C.Z. there are 8 specimens from Oriente, Sta. Clara (Soledad) and Habana.

46. Danaus gilippus berenice

Papilio berenice Cramer, Pap. Ex., 3, p. 22, pl. 205, f. E, F, (1779).
Danais berenice: Poey, 1847, p. 176; *id.*, 1852, p. 198; Herrich-Schäffer, 1864b, p. 161; Gundlach, 1881, p. 24; Haensch in Seitz, V, p. 114, pl. 31a (1909); Holland, 1931, p. 69, pl. 7, f. 2.
Anosia berenice: Holland, 1916, p. 488.
Danaida berenice berenice: Hulstaert, 1931, p. 23, pl. 1, f. 1.

This species is dark brown, with the costal and outer margins of the forewing and the outer margin of the hindwing bordered with black, which may include a double row of small white spots, although these are usually absent on the hindwing. There are several white spots at the apex of the forewing, and other spots between veins M_3 and Cu_1, Cu_1 and Cu_2, Cu_2 and 2A. The under side is similar, except that the veins of the hindwing are outlined in black, edged with white, and that the white spots in the black wing border are usually all present. Length of f.w., 34–44 mm.

Met. The larva feeds on *Asclepias*.

Dist. This species is found almost everywhere in tropical America, and extends well into the temperate zones. The first described choromorph is South American; *berenice* occurs in the southern United States, Central America and Cuba; distinct choromorphs are found on Hispaniola (*cleothera*) and Jamaica (*jamaicensis*). These forms all show very distinct pattern characters, but in genital structure they are almost identical.

In the M.C.Z. there are 22 specimens from Oriente, Sta. Clara (Soledad) and Habana.

47. Danaus eresimus

Papilio eresimus Cramer, Pap. Ex., 2, p. 121, pl. 175, f. G, H (1777).
Danais eresimus: Haensch in Seitz, V, p. 114, pl. 31b, (1909); Kaye, 1931, p. 532.

This species is very similar to *berenice* on the upper side. It may be easily distinguished, however, by the characters given in the key. Length of f.w., 37–43 mm.

D. eresimus is rather rare in collections, despite its wide range; probably it is usually overlooked by collectors because of its resemblance to the common *berenice*. There are two color forms in the Cuban material that I have studied: a dark form, very like *berenice*, which agrees well with the dark Ecuadorean *erginus*, and a lighter form, very like the common Hispaniolan type, described as *Danais kaempfferi* by Hall (1925, p. 165). I have seen specimens from Jamaica, Hispaniola,

Martinique, Florida and Cuba, as well as from many localities on the mainland. By a little judicious switching of locality labels, it would be possible to make some fine races; but as the labels stand, and until more material is available, I think it is better to leave all of these forms under one name.

Dist. In the M.C.Z. there is a male from Sta. Clara (Soledad), and another from Oriente (Sierra Maestra, 1000 ft.), both very dark. In the U.S.N.M. there is a light colored female from Matanzas. In the A.N.S.P. there are two females and a male from Guantanamo, all very light colored.

Genus XIII. Lycorea Doubleday

Genotype, *Lycorea atergatis* Doubleday.
Lycorella Hemming, genotype *Heliconia cleobaea* Godart.

Hemming (1933, p. 222) proposed a new name for this genus on the assumption that *Lycorea* Doubleday (1847) was preoccupied by *Lycoria* Meigen (1800). The International Rules (1926, p. 87, Art. 36) seem to me clear on this point: "When once introduced [generic names which differ only in a slight variation in spelling which might cause confusion] are not to be rejected on this account."

48. Lycorea ceres demeter

Heliconia pasinuntia: Poey, 1847, p. 177.
Lycorea ceres: Herrich-Schäffer, 1862, p. 119; *id.*, 1864b, p. 161.
Lycorea demeter Felder & Felder, Reise Novara, p. 352 (1867); Gundlach, 1881, p. 19.
Lycorea ceres demeter: Haensch in Seitz, V, p. 115 (1909); Hulstaert, 1931, p. 188.

The large size and robust build of this insect will distinguish it from the Cuban *Eueides*, the only other long-winged black and brown butterfly on the island. The forewing is black, with three or four small yellowish apical spots, and a series of large connecting yellow spots across the end of the cell; the base of the cell is brown, and there is a large brown band near the inner margin. The hindwing is brown and black, with a row of tiny submarginal white spots. The under side is similar to the upper. Length of f.w., 48–50 mm.

Met. Gundlach found the larva, which he did not describe, on species of "Jagüey" (*Ficus*).

Dist. This form is known only from Cuba and Hispaniola; the species is widely distributed on the tropical mainland. Gundlach

states that in Cuba "it inhabits the forests over the whole island, but not in all localities; it is at times common." In the M.C.Z. there are 8 specimens from Oriente ("Cuba, Wright" and Torquino River); the U.S.N.M. specimens are from Baracoa.

Genus XIV. Anelia Hübner

Genotype, *Anelia numidia* Hübner.
Clothilda Blanchard, genotype *Papilio pantherata* Martyn.

This genus has been generally placed in the Nymphalidae, largely because two of the species look something like *Argynnis*. It seems unquestionably to be a true Danaid, fairly close in many respects to *Lycorea*. It may possibly serve as a clue to the phylogeny of the family, as its distribution seems to be of a relict sort. Gundlach (1881, p. 28) quotes Poey to the effect that "the head of the larva is black and thick, the body white and smooth, with two transverse lines (black?) on the first segment. The chrysalid resembles that of *Danais*." The genitalia are typically Danaid, with well developed hair tufts; the base of the anal vein of the forewing is forked.

The confusion in the application of the names *numidia* and *pantherata* is unfortunate. Hübner included the two species under *Anelia numidia*, one as male, the other as female; following the principle of page precedence, I have applied the name to the first figured, the male.

Key to species

1. F.w. dark brown above, with a row of white spots extending from the costal margin to the outer angle.....51. *A. cubana*
   F.w. light brown, with numerous darker spots.....2
2. H.w. above with three rows of dark spots, besides those on the margin of the wing.....49. *A. numidia*
   Only two rows of spots on h.w. above.....50. *A. pantherata*

49. Anelia numidia numidia

Fig. 9, venation

Anelia numidia Hübner, Ex. Schm., 2, pl. 22, f. 1, 2 (182–).
Danais numidia: Poey, 1847, p. 176.
Clothilda pantherata: Herrich-Schäffer, 1864b, p. 161; Gundlach, 1881, p. 28; Seitz, V, p. 402 (1913).
Clothilda numida: Salvin, 1869, p. 393; Hall, 1925, p. 186.
Clothilda numidia: Hall, 1930, p. 13.

This butterfly looks strikingly like a North American *Argynnis*, although not at all related to that group. Above, the wings are light brown, with narrow dark borders which include light spots between

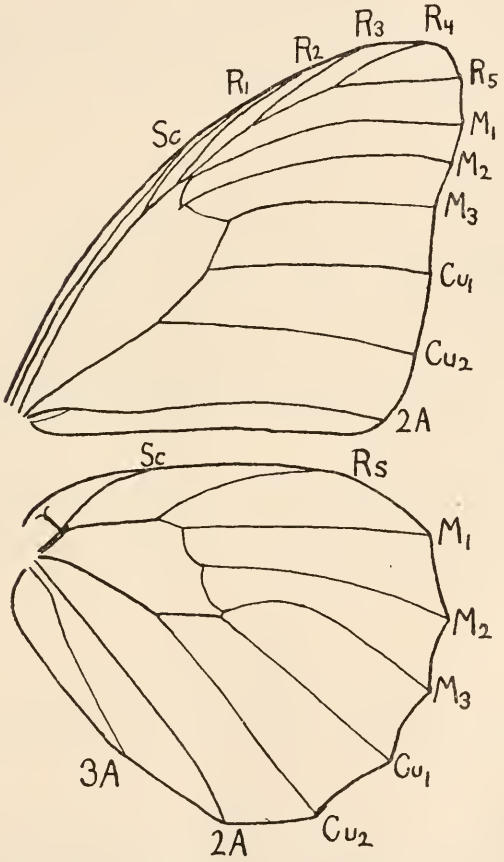

Fig. 9. *Anelia numidia*, venation.

the veins. Both wings are crossed by three rows of dark spots. This pattern is repeated on the under side of the forewing, but the hindwing is quite different, mottled with light and dark brown, with numerous irregular fine white lines. The females are somewhat lighter in color than the males. Length of f.w., 38–45 mm.

Met. Gundlach (quoting Poey) states that the larva lives on the shrub called "Espuela de Caballero" (*Jacquinia*, family Theophrastaceae).

Dist. This species is found only in Cuba and Hispaniola. Gundlach found it in the vicinity of Matanzas; we observed it quite commonly in the Trinidad Mountains at altitudes above 2,000 ft. There are 22 specimens in the M.C.Z. from Oriente (Torquino, 100 and 3,000 ft., Querci) and Sta. Clara (Buenos Aires, 3,000 ft., San Blas, 600 and 2,000 ft.).

50. Anelia pantherata clarescens

Anelia numidia Hübner, Ex. Schm., II, pl. 23, f. 3, 4, (182–).
Clothilda numida: Gundlach, 1881, pl. 27; Seitz, V, p. 402, pl. 83d, e, (1913).
Clothilda pantherata clarescens Hall, 1925, p. 186; *id.*, 1930, p. 13.

This species is similar to the preceding, from which it may be distinguished by the character pointed out in the key, and by the under side of the hindwing, which is rather differently marked. Length of f.w., 46–50 mm.

Dist. This form is known only from Cuba, *pantherata* only from Hispaniola. Gundlach considered this to be commoner than the preceding species, but there are only three specimens in the M.C.Z., all from Oriente ("Cuba, Wright").

51. Anelia cubana

Clothilda jaegeri: Herrich-Schäffer, 1862, p. 119; *id.*, 1864b, p. 161.
Clothilda cubana Salvin, 1869, p. 396; Gundlach, 1881, p. 28; Seitz, V, p. 402, pl. 83d, e, (1913).

The wings above are very dark brown, the forewing crossed by a band of white spots, the hindwing by an almost straight whitish postdiscal band. On the under side there are some red markings on the discal area of the forewing, and irregular blue lines in the base of the cell, in addition to the white spots. The hindwing is fuscous, with a diffuse light shading on the postdiscal area. Length of f.w., 47–57 mm.

Dist. This species is known only from Cuba; it may be a choromorph of the Hispaniolan *jaegeri* which I have not seen. The U.S.N.M. has a beautiful series of 8 specimens from Oriente (Tanamo), col-

lected by Schaus and Barnes; Dr. Schaus kindly presented one of these to the M.C.Z.

Genus XV. Hymenitis Hübner

Genotype, *Papilio diaphanus* Drury.

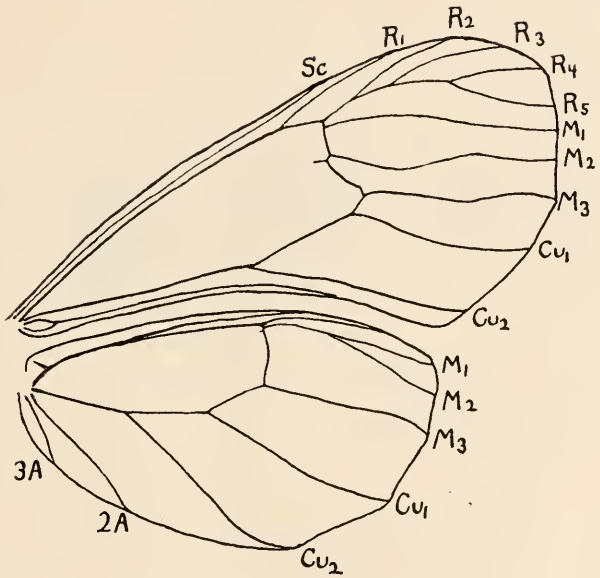

Fig. 10. *Hymenitis cubana*, venation.

52. Hymenitis cubana

Fig. 10, venation

Hymenitis cubana Herrich-Schäffer, 1862, p. 118; *id.*, 1864b, p. 161; Gundlach, 1881, p. 19; Haensch in Seitz, V, p. 164 (1910).

This insect is at once recognizable as the only Cuban butterfly with transparent wings. The apex of the forewing is dark grey, with a white subapical band, and both wings have a narrow grey margin, brown on the underside; otherwise the wings are quite transparent. Length of f.w., 26–29 mm.

Met. Gundlach states that the larva lives on "Galan" (*Cestrum*), but he does not describe it.

Dist. This species is limited to Cuba where, according to Gundlach, it inhabits the mountains of both ends of the island, but not the central Trinidad range. In the M.C.Z. there are 11 specimens from Oriente ("Cuba, Wright," and Sierra Maestra, 1000 ft., July and Feb., Querci).

Family IV. SATYRIDAE

This large family is represented in the Greater Antilles by only one genus, with one species in Cuba, another in Jamaica, several in Hispaniola, and one in Puerto Rico.

Genus XVI. Calisto Hübner

Genotype, *Calisto herophile* Hübner.

53. Calisto herophile

Fig. 11, venation

Calisto herophile Hübner, Ex. Schm., Zutr., 2nd Hndrd., p. 16, f. 269, 270 (1823); Herrich-Schäffer, 1864b, p. 161; Lathy, 1899, p. 226, pl. 4, f. 8, 9; Gundlach, 1881, p. 26; Holland, 1916, p. 494; Weymer in Seitz, V, p. 240, pl. 51f (1911); Gaede, 1931, p. 479.
Satyrus herophile: Poey, 1847, p. 179.

The upper side is dark grey, darker at the base of the wings; in the male the scales at the base of the forewing are modified to form a broad "stigma," as indicated in the figure. The ground color of the under side is lighter grey, marked with various dark lines and spots. On the forewing there is a subapical ocellus, and a small ochraceous patch near the base of the costa; the hindwing has an eyespot near

the anal angle, and a postdiscal row of tiny white spots, which are occasionally surrounded by a bluish area. Length of f.w., 15–19 mm.

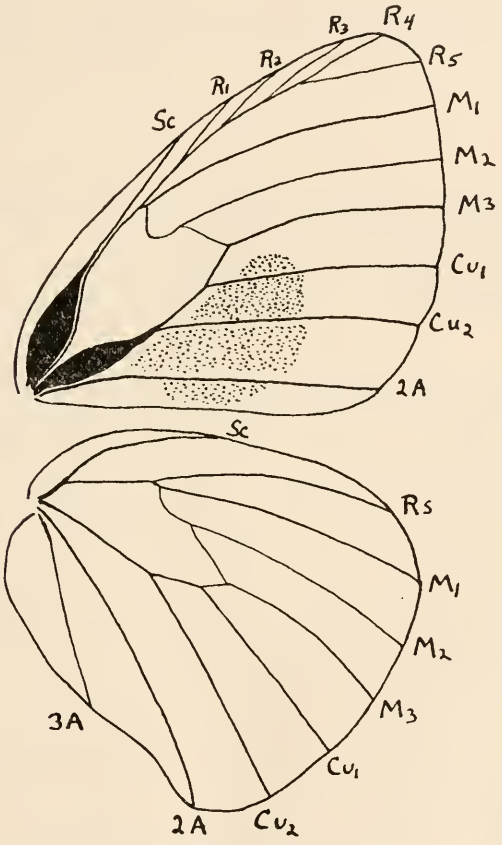

Fig. 11. *Calisto herophile*, venation.

Dist. This species is limited to Cuba, the Isle of Pines and the Bahamas, where it is everywhere common. In the M.C.Z. there are 88 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Family V. NYMPHALIDAE

This family includes most of the common, brightly marked roadside butterflies. The group has never been thoroughly monographed, and as a result, its classification is in a very confused state.

Key to genera

1. H.w. with cell closed by a normally developed vein, clearly discernable on the upper side without denuding the wings.[1] 2
   Cell of h.w. open, or closed by a vestigial vein.....3
2. Antennae about half as long as f.w. or longer, club elongate, gradually thickened; Cuban species black with yellow bars. XVII. *Heliconius*
   Antennae less than half as long as f.w., club shorter, distinct; Cuban species brown, with black bars and some light spots at apex of f.w.....XVIII. *Eucides*
3. Cubital vein of f.w. inflated from the base nearly to the first branch (as in the Satyrids).....4
   Cu normal.....5
4. Cell of f.w. open; brown butterflies, with blue eyespots on h.w. beneath.....XXXIV. *Lucinia*
   Cell of f.w. closed; dark grey butterflies, usually with some white spots on the apex of f.w.....XXXV. *Eunica*
5. Discal cell of f.w. closed by a distinct vein, or by a rudimentary vein that can usually be seen from the under side.[2].....6
   This cell open.....20
6. M_2 of f.w. arising about halfway between M_1 and M_3; brown butterflies with dark markings.....7
   The distance between the bases of M_1 and M_2 is $\frac{1}{3}$ or less of that between M_1 and M_3; variously colored butterflies.....9

[1]Cuban genera with the cell of the hindwing closed by a vestigial vein, liable to cause confusion, are: *Vanessa*, *Hypolimnas*, *Colobura* and *Anaea*. All of these have normally shaped wings, while the genera in couplet 2 have narrow, elongate forewings.

[2]The following genera with the cell partially closed (go to couplet 6) may cause confusion: *Phyciodes*, small checkered brown butterflies; *Dynamine*, small species with two ocelli on the under side of the hindwing; *Prepona*, large black butterflies with a prominent blue median band on both wings.

Precis, a genus of grey butterflies with two large ocelli on the hindwing above, has the cell open, although the scaling sometimes gives the appearance of a vein; they go to couplet 20.

7. Precostal vein of h.w. bent away from the base of the wing; wings normal in shape, not marked with silver beneath. XXI. *Euptoieta*

PC vein bent toward the base of the wing; f.w. elongate, or the under side marked with silver 8

8. No silver spots on under side; paronychia and pulvillus present on claws of hind tarsi . . . . . XIX. *Colaenis*

H.w. and apex of f.w. beneath strikingly marked with silver spots; paronychia and pulvillus absent . . . . . XX. *Dione*

9. Antennae with a distinct club, usually colored or marked differently from the shaft; either compressed or spindle shaped . . . 10

Antennae thickening gradually toward the tip 15

10. R_1 of f.w. branches off the radial stem before the end of the cell, the radius not branching again until considerably beyond the cell 11

R_1 and R_2 branch off before the end of the cell 12

11. 3rd joint of palpus long and thin; outer margin of f.w. excavated in the region of Cu_1, or evenly rounded, but not noticeably produced apically; quite small brown butterflies with checkered markings. (Fig. 12, venation.) . . . . . XXII. *Phyciodes*

3rd joint of palpus thicker; apex of f.w. distinctly produced; larger butterflies, the only Cuban species with a submarginal row of white spots in the heavy black border of f.w. above. XXIII. *Chlosyne*

12. H.w. with short, slender tails at M_3 and Cu_2; the Cuban species brown with some silvery markings on the under side. XXV. *Hypanartia*

H.w. not tailed or lobed; not marked as above 13

13. Cell of h.w. open; small species, f.w. less than 22 mm. long; h.w. marked with white on under side, with two dark eyespots. XXXVI. *Dynamine*

Cell of h.w. closed by a vestigial vein; large species, f.w. more than 24 mm. long, variously colored 14

14. Eyes naked; male black, with four large oval white spots on wings above; female uniform brown except for thin marginal markings and the black apex of f.w., which is marked with white. XXX. *Hypolimnas*

Eyes hairy; one species black, with a red bar on f.w.; the others brown marked with black, and with eyespots on h.w. beneath. XXIV. *Vanessa*

15. The first branches of radius of f.w. fuse with Sc, or seem to cross it; h.w. with a short but distinct tail at M_3 (Fig. 13, venation). XLII. *Anaea*

    Sc of f.w. free; no tail at M_3 of h.w., or at most (*Coea*) a slight lobe 16

16. Eyes hairy; wing pattern including a pearly white band on the upper side of both wings . . . . . XXXVII. *Adelpha*

    Eyes naked; no white band on wings above 17

17. H.w. distinctly lobed at the anal angle, including veins Cu_2 and 2A in the lobe; f.w. above marked with red or yellow 18

    H.w. rounded at anal angle; f.w. above marked with blue, or brown with white spots 19

18. Antennae more than half as long as costa of f.w.; wings grey above with a broad yellow bar across f.w. . . . . XXXIII. *Colobura*

    Antennae shorter; wings black and red . . . . . XLI. *Siderone*

19. Palpi long, projecting forward; h.w. dentate at M_3; upper side of wings brown, apex of f.w. black with some white spots. XXXII. *Coea*

    Palpi erect, appressed to the front of the head; h.w. not toothed at M_3; wings black above, with prominent central blue bands. XL. *Prepona*

20. R_1 and R_2 of f.w. fuse with Sc and seem to cross it, much as in *Anaea* (Fig. 13); two very common species, one white above marked with wavy dark lines; the other dark brown, with a white patch in the center of each wing. . . . . XXVII. *Anartia*

    R_1 and R_2 free from Sc; not marked as above 21

21. H.w. with a long slender tail at M_3, in addition to a prominent lobe at the anal angle. . . . . XXIX. *Athena*

    H.w. at most lobed or toothed at M_3 22

22. H.w. toothed at M_3; a large butterfly with large translucent light green spots on wings . . . . . XXVIII. *Metamorpha*

    H.w. not toothed at M_3; no translucent green spots 23

23. R_2 of f.w. arising beyond end of cell; brown butterflies, with a row of small eyespots between the veins on the under side of h.w. XXXIX. *Asterocampa*

    R_2 and R_1 of f.w. both arising before end of cell; no eyespots on h.w. below, or only two or three 24

24. Two prominent eyespots on h.w. above; M_2 of f.w. connected with M_1 by a curved discocellular vein that is about $\frac{1}{3}$ as long as the distance between M_1 and M_3 . . . . . XXVI. *Precis*

No eyespots on wings above; discocellular between M_2 and M_1 short, occupying much less than ⅓ of the distance between M_1 and M_3 25

25. A large and powerful butterfly, above entirely brown and black, except for a white spot at the apex of f.w.; R_3 parallels R_{4-5} of f.w. for some distance before diverging to the costa. XXXI. *Historis*

Medium-sized butterflies, dark grey, with a white median line on h.w., which in the male is included in a purple reflecting area; R_3 diverges steadily from its point of origin near the cell toward the costa..... XXXVIII. *Doxocopa*

Genus XVII. Heliconius Kluk

Genotype, *Papilio charithonia* Linnaeus.

Heliconius Latreille, genotype *Papilio antiochus* Linnaeus.
Migonitis Hübner (*nec* Rafinesque), genotype *Papilio erato* Linn.
Apostraphia Hübner, genotype *Papilio charithonia* Linn.

Here, as in *Danaus*, I have followed Hemming (1933, p. 223); if the Kluk reference is unavailable, the genus can be dated from Latreille, with a change in genotype but no change in significance.

54. Heliconius charithonia charithonia

Papilio charithonia, Linnaeus, 1767, p. 757.
Heliconia charitonia: Poey, 1847, p. 176; Herrich-Schäffer, 1864b, p. 161.
Heliconius charithonia: Gundlach, 1881, p. 20; Holland, 1916, p. 488; Holland, 1931, p. 75, pl. 8, f. 5.
Heliconius charithonia charithonia: Stichel & Riffarth, 1905, p. 214; Seitz, V, p. 394, pl. 79a (1913); Neustetter, 1929, p. 67.

This is a striking butterfly, at once distinguishable from anything else occurring north of Panama by the long, narrow black wings, crossed by bright yellow bars: three on the forewing and a median one on the hindwing, where there is also a complete row of small yellow submarginal spots.

The species has a remarkably constant pattern throughout its wide range; West Indian specimens perhaps tend to vary more than continental ones, but the insular races are not very well marked. The most striking aberration that I have seen is one of our Cuban speci-

mens, in which the wings are dark brown, with the usual yellow markings replaced by light brown, with many white scales. Other specimens from Cuba and Hispaniola show varying amounts of brown scaling in the yellow. An additional yellow spot on Cu_1 of the forewing is present on five specimens from Cuba, one from St. Thomas, and one from Jamaica; it is also sometimes found on Florida specimens. The width of the yellow bands varies greatly; they are sometimes especially narrow in Hispaniolan specimens, and invariably especially wide in the Jamaican form. There is an astonishing variation in size in our Cuban series, the costal length ranging from 32 to 46 mm. in captured specimens.

Met. The larva, which has often been described, lives on *Passiflora*.

Dist. The typical subspecies extends from the southern United States to Venezuela and Colombia; a distinct choromorph is found in Ecuador and Peru, and another in Jamaica. There are 55 Cuban specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana.

Genus XVIII. Eueides Hübner

Genotype, *Nerëis dianasa* Hübner.

55. Eueides cleobaea cleobaea

Eueides cleobaea Geyer in Hübner, Zutr., 4th Hndrd., p. 7, f. 601, 602 (1832); Herrich-Schäffer, 1864b, p. 161; Gundlach, 1881, p. 22; *id.*, 1891, p. 445; Seitz, V, p. 398 (1913).

Heliconia isabella: Poey, 1847, p. 177.

Eueides cleobaea cleobaea: Stichel & Riffarth, 1905, p. 242; Neustetter, 1929, p. 115.

The forewing is brown, the apex black, with two rows of light brown spots; the middle of the cell is also black, as is the area between veins Cu_2 and 2A. The hindwing is black and brown, with a submarginal row of tiny white spots. The under side is similar to the upper. Length of f.w., 36–38 mm.

Met. The larva lives on *Passiflora*, according to Gundlach (1891); the earlier record from *Asclepias* was in error.

Dist. This species is widespread in Middle America. The Cuban form, which has two color varieties, with the spots on the forewing either light brown or yellow, differs but slightly from the Central American choromorph. The subspecies found on Hispaniola is more distinct.

There are six specimens in the M.C.Z. from Oriente; according to Gundlach, the species is found in all parts of Cuba, but very locally.

Genus XIX. Colaenis Hübner

Genotype, *Papilio julia* Fabricius.

56. Colaenis julia nudeola

Argynnis delila: Poey, 1847, p. 124.
Colaenis delila: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 55.
Colaenis julia cillene: Stichel, 1907, p. 12, pl. 2, f. 1; Holland, 1916, p. 489; Seitz, V, p. 400, pl. 84b (1913); Riley, 1926, p. 240.
C. julia cillene form *nudeola* Stichel, 1907, p. 12.

The forewing above is light brown, devoid of markings in the male except for a triangular black spot at the end of the cell, and a small spot on the base of M_3, which may be absent. The veins are usually lightly outlined with black, and the outer margin is thinly bordered with black. The hindwing is brown except for a narrow border of black on the outer margin. The underside is lighter, slightly mottled. The female is darker than the male, with heavier borders on the wings, and with a black band crossing the forewing from the tip of the cell to the outer margin, between veins M_3 and Cu_1; it is occasionally interrupted near the margin. There is also a black shading between veins Cu_2 and 2A, sometimes forming a definite bar. Length of f.w., 37–39 mm.

I have not seen any immaculate Cuban specimens (typical form *nudeola*), but Stichel's name seems to be the only one available for the Cuban subspecies. The type of Cramer's *cillene* probably came from Surinam, as he states in the original description; it is exceedingly unlikely that he had Cuban material.

Met. The larva, which was described by Gundlach, lives on *Passiflora*.

Dist. This species is found almost everywhere in tropical America, and it is made up of a rather large number of well defined choromorphs. *Nudeola* is limited to Cuba, the Bahamas and southern Florida; distinct forms inhabit Hispaniola, Jamaica and many of the Lesser Antilles. In the M.C.Z. there are 48 specimens from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Oriente, Pinar del Rio and the Isle of Pines.

Genus XX. Dione Hübner

Genotype, *Papilio juno* Cramer.

57. Dione vanillae insularis

Argynnis passiflorae: Poey, 1847, p. 124.
Agraulis vanillae: Herrich-Schäffer, 1864b, p. 163.
Dione vanillae: Gundlach, 1881, p. 57; Seitz, V, p. 401, pl. 84f (1913); Holland, 1931, p. 79, pl. 8, f. 7.
Agraulis insularis Maynard, 1889, p. 89, pl. 8, f. 1a, 1b.
Dione vanillae insularis: Stichel, 1907, p. 19; Holland 1916, p. 490; Riley, 1926, p. 243.

The large silver spots on the under side of this butterfly at once separate it from all of the other Cuban species. The upper side is brown, with various black markings, especially on the veins of the forewing and along the outer margin of the hindwing. Length of f.w., 27–34 mm.

Met. The larva, which feeds on *Passiflora,* has often been described.

Dist. The choromorphs of *D. vanillae* are for the most part not clearly defined. Cuban specimens are very like those from the Bahamas (type locality of *insularis*) and from the other islands of the Greater Antilles; the same form is common in southern Florida, and it probably merges imperceptibly with the Central American *incarnata* in the southern United States. The differences between *insularis* and the typical *vanillae* of northern South America are slight and not constant. The butterfly is found almost everywhere in the American tropics, even on isolated islets; it must be a great wanderer, and it is not surprising that well marked choromorphs are not found in the West Indies.

There are 48 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Oriente, Pinar del Rio and the Isle of Pines.

Genus XXI. Euptoieta Hübner

Genotype, *Papilio claudia* Cramer.

58. Euptoieta hegesia

Papilio hegesia Cramer, Pap. Ex., III, p. 30, pl. 209, f. E. F, (1779).
Argynnis hegesia: Poey, 1847, p. 124.
Euptoieta columbina: Herrich-Schäffer, 1864b, p. 162.
Euptoieta hegesia: Gundlach, 1881, p. 44; *id.*, 1891, p. 447; Seitz, V, p. 404, pl. 85a (1913); Holland, 1916, p. 491; *id.*, 1931, p. 81, pl. 8, f. 8.

The upper side of this species is brown, marked with numerous black lines and spots on the forewing; the hindwing is immaculate except for a double black line on the margin, and a submarginal row of small round black spots. The under side of the hindwing is somewhat variable; it is usually mottled with brown and grey, with a fine network of dark lines. Length of f.w., 21–30 mm.

Met. Gundlach found the larva on "Mari-Lope" (*Turnera*).

Dist. This species is widely distributed in the American tropics; the type locality is Jamaica, and the West Indian population seems homogeneous, although possibly distinct from that found on the continent. In the M.C.Z. there are 54 specimens from Oriente, Sta. Clara and Habana. We did not find it in the immediate vicinity of Soledad, although it was rather common in the mountains.

Genus XXII. Phyciodes Hübner

Genotype, *Papilio tharos* Drury.

This genus has recently been monographed by Hall (1928–30).

Key to species

1. Under side of f.w. with a square dark brown spot between veins M_3–Cu_2, which sends two teeth down into the 2A–Cu_2 area. 61. *P. frisia*
   Under side of f.w. without such a spot 2
2. M_3–Cu_2 area on under side of f.w. dark brown basally, then cream, then orange, and finally, on the outer margin, dark brown, with a cream colored spot between M_3–Cu_1 . . . . . 59. *P. phaon*
   This area reddish brown, with a coarse black network. 60. *P. pelops*

59. Phyciodes phaon phaon

Melitaea phaon Edwards, 1864, p. 505.
Phyciodes phaon: Röber in Seitz, V, p. 436 (1913), pl. 89c; Holland, 1931, p.137. pl. 17, f. 22, 23.
Phyciodes phaon phaon: Hall, 1928, p. 40.

This little butterfly seems not to have been reported from Cuba previously. It may be distinguished from the common *P. frisia* by its more variegated pattern, which includes on the forewing above a light band that runs from near the middle of the costa to the inner margin: this band is always interrupted in the middle in *P. frisia*. The under surface is quite differently marked in the two species.

Dist. This species occurs over the southern United States and northern Central America; Hall has described a subspecies from Guatemala. There is one specimen in the M.C.Z. from Cojimar, near Habana, Nov. 23, 1930, collected by S. C. Bruner; the U.S.N.M. has four specimens from Habana.

60. Phyciodes pelops aegon

Papilio aegon Fabricius, 1781, p. 130.
Melitaea anocaona Herrich-Schäffer, 1864b, p. 162.
Phyciodes pelops: Gundlach, 1881, p. 53; Röber in Seitz, V, p. 437, pl. 89f (1913).
Phyciodes pelops aegon: Hall, 1929, p. 61.

This is one of the smallest species of the genus. Above the wings are entirely covered with a checkered pattern of reddish-brown and black. The forewing on the under side is reddish-brown with some black lines and spots; the hindwing has a complicated pattern, usually much brighter and clearer in the female than in the male. The males have a curious tuft of hair on the inner margin of the hindwing above, which folds into a pocket along this margin. Length of f.w., 8–11 mm.

Dist. Hall gives Jamaica and Cuba as the habitat of this form, Hispaniola, Puerto Rico and St. Kitts as the habitat of *P. pelops pelops*. This is, then, the only butterfly known with one subspecies common to Jamaica and Cuba, and another subspecies in Hispaniola; I have seen no Jamaican specimens, so I cannot check this arrangement. There are 91 specimens in the M.C.Z. from Oriente, Sta. Clara (only near the coast) and Habana.

61. Phyciodes frisia frisia

Fig. 12, venation

Melitaea frisia Poey, 1832, no. 2, 3 figs.; *id.*, 1847, p. 125.
Eresia frisia: Herrich-Schäffer, 1864b, p. 162; Holland, 1916, p. 491.
Phyciodes frisia: Gundlach, 1881, p. 53; Röber in Seitz, V, p. 437, pl. 89e (1913).
Phyciodes frisia frisia: Hall, 1929, p. 83.
Anthanassa frisia: Holland, 1931, p. 140, pl. 17, f. 42.

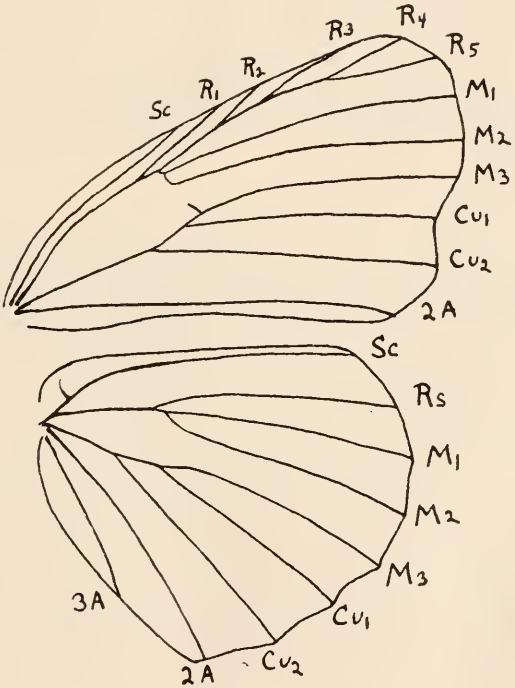

Fig. 12. *Phyciodes frisia frisia*, venation.

The outer half of the forewing above is mostly black, with some light brown spots; the hindwing is brown, with lighter and darker bands and spots. The ground color beneath is lighter, with a somewhat more complicated pattern. The sexes are similar. Length of f.w., 12–20 mm.

Dist. This subspecies is found in Florida and the Greater Antilles; other choromorphs occur in Central America and northern South America. In the M.C.Z. there are 37 specimens from Oriente, Sta. Clara (Soledad) and Habana; the U.S.N.M. specimens are from Oriente and the Isle of Pines.

Genus XXIII. Chlosyne Butler

Genotype, *Papilio janais* Drury.

62. Chlosyne perezi perezi

Synchloe perezi Herrich-Schäffer, 1862, p. 119; *id.*, 1864, p. 162.
Chlosyne perezi: Gundlach, 1881, p. 54; Röber in Seitz, V, p. 452, pl. 91h (1914).
Chlosyne perezi perezi: Forbes, 1928, p. 98.

The ground color is very dark brown, with three broken reddish-brown bands across the basal half of both wings, sometimes merging on the hindwing, and a submarginal row of white spots on the forewing. The forewing is similar on the under side; the hindwing has some yellow and white spots toward the base, a postdiscal row of reddish-brown spots, and a submarginal row of white V-shaped spots. Length of f.w., 24–30 mm.

Dist. This choromorph is limited to Cuba, where Gundlach found it in the vicinity of Baracoa. I have not seen the related forms *pantoni* (Jamaica) and *tulita* (Puerto Rico, ?Hispaniola), so that I cannot judge whether they should be considered as species or not; I have followed Forbes in making them subspecies. The only specimens of *perezi* in the M.C.Z. are a pair from the original lot, received through Scudder. The U.S.N.M. has a nice series from Santiago de Cuba.

Genus XXIV. Vanessa Fabricius

Genotype, *Papilio atalanta* Linnaeus.
Pyrameis Hübner, genotype *Papilio atalanta* Linn.

This is an instance where departure from the International Rules seems necessary. The genotype of *Cynthia* Fabricius is *Papilio cardui* Linn.; *Cynthia* has page precedence over *Vanessa* and therefore should be the generic name for the *atalanta-cardui* group of butterflies. Un-

fortunately *Cynthia* has been used almost universally since 1849 for an Indo-Australian group of butterflies with *Papilio arsinoe* Cramer as genotype. A change of names, then, cannot be made without taking both groups into consideration. In any event, there would probably be less confusion if *Vanessa*, type *atalanta*, and *Cynthia*, type *arsinoe*, were treated as *nomina conserranda*.

Key to Species

1. F.w. above black, crossed by an orange band that extends from the costa to the outer angle ..... 63. *V. atalanta*
   F.w. above brown, with no such band 2
2. H.w. below with two large eyespots ..... 64. *V. virginiensis*
   H.w. below with a submarginal row of at least four eyespots 65. *V. cardui*

63. Vanessa atalanta

Papilio atalanta Linnaeus, 1758, p. 478.
Vanessa atalanta: Poey, 1847, p. 122; Holland, 1931, p. 153, pl. 43, f. 4.
Pyrameis atalanta: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 39; Seitz, V, p. 458, pl. 94a (1914).

The upper surface is black, the forewing with a transverse orange bar and some white subapical spots; the hindwing with a broad orange band on the outer margin. The pattern of the under side is more variegated and complex. Length of f.w., 30–35 mm.

Met. The food plants of this species in the United States are *Humulus*, *Boehmeria*, *Urtica* and *Parietaria*.

Dist. This is a common species in North America, Europe and temperate Asia. In Cuba, Gundlach found it near Güines and San Jose de las Lajas (Habana) and near Cienfuegos (Sta. Clara); I caught a single male at San Blas, in the Trinidad Mountains (600 ft.), Sta. Clara. There are two specimens in the M.C.Z. from Hispaniola, but it has not yet been found on the other islands.

64. Vanessa virginiensis virginiensis

Papilio cardui virginiensis Drury, 1770, [p. 10], index, pl. 5, f. 1 [1773].
Pyrameis huntera: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 41.
Pyrameis virginiensis: Seitz, V, p. 459, pl. 94b (1914).
Vanessa virginiensis: Holland, 1931, p. 154, pl. 1, f. 2; pl. 33, f. 6.

This and the following species are very similar on the upper side, but they may be at once distinguished by the eyespots of the under side, as pointed out in the key. The upper side is brown, with various angular dark spots, and some apical white spots on the forewing; the hindwing is similar, with the ocelli of the under side represented by a row of black submarginal spots. Length of f.w., 25–30 mm.

Met. The food plants listed in the literature on this species include *Gnaphalium, Arctium, Helianthus* and *Antennaria.*

Dist. This is a common North American butterfly, which Gundlach found in Cuba only on the mountain called "Gran Piedra" to the east of Santiago de Cuba (Oriente); I have seen no Cuban specimens. It is also reported from the other West Indian islands, and several choromorphs have been described from South America.

65. Vanessa cardui

Papilio cardui Linnaeus, 1758, p. 475.
Vanessa cardui: Poey, 1847, p. 122; Holland, 1931, p. 154, pl. 1, f.1.
Pyrameis cardui: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 40; Seitz, V, p. 458 (1914).

The salient characters of this species have already been pointed out. The general pattern of the under side of the hindwing is quite different from that of *virginiensis.* Length of f. w., about 30 mm.

Met. The food plants include *Carduus, Althaea, Cnicus, Silybum, Onopordon, Arctium,* etc.

Dist. This cosmopolitan species occurs sparingly in Cuba in October, according to Gundlach; he does not mention any specific localities. I have seen no Cuban specimens.

Genus XXV. Hypanartia Hübner

Genotype, *Papilio paullus* Fabricius.

66. Hypanartia paullus

Papilio paullus Fabricius, 1793, p. 63.
Hypanartia tecmesia Hübner, Ex. Schm., II, pl. 27, 4 figs. (182–).
Vanessa lethe: Poey, 1847, p. 123.
Eurema tecmesia: Herrich-Schäffer, 1864b, p. 161.
Hypanartia paullus: Gundlach, 1881, p. 38; Seitz, V, p. 460, pl. 94c (1914).

The ground color above is brown, with some dark brown bands on the apical half of the forewing of the male, and a double dark marginal band in both sexes. The hindwing is brown, with dark submarginal lines, and a black anal spot with some central blue scaling; this wing is toothed at M_3 and Cu_2. The wings are more variegated on the under side, with various wavy lines of brown and silvery white. The male is darker than the female. Length of f.w., 27–32 mm.

Dist. This species is found only in the West Indies, where it occurs on all of the large islands. There are 4 specimens in the M.C.Z. from Oriente (Torquino River, 100 and 3000 ft.). The U.S.N.M. specimens are also from Oriente (Tanamo).

Genus XXVI. Precis Hübner

Genotype, *Papilio octavia* Cramer.
Junonia Hübner, genotype *Papilio lavinia* Cramer.

There are two species of *Precis* in Cuba, distinct both in general habitus, and in the structure of the male genitalia. The precise nomenclature of these two forms, however, must depend on their relationship with the numerous continental varieties, and cannot be decided here. The American species of the genus need revision, but the task must be done by someone with ample material, with access to the types, and with sufficient patience to untangle the complicated bibliography that has grown up around the various names.

Key to species

1. First ocellus (M_1–M_2) on h.w. above several times as large as the other ocellus, the distal half black, the proximal half pale. 65. *P. coenia*

   This ocellus but little larger than the posterior ocellus, symmetrical, black except for a few purplish scales . . . . . 68. *P. zonalis*

67. Precis coenia

Junonia coenia Hübner, Ex. Schm., 2, pl. 32, 4 figs. (182–); Herrich-Schäffer, 1864b, p. 163; Holland, 1916, p. 492; *id.*, 1931, p. 156, pl. 20, f. 7.
Vanessa coenia: Poey, 1852, p. 198.
Junonia genoveva: Gundlach, 1881, p. 65.
Precis lavinia coenia: Seitz, V, p. 461, pl. 94e (1914).
Junonia lavinia coenia: Forbes, 1928b, p. 306.

The ground color of the upper side is brownish grey. On the forewing there is a small ocellus between M_1 and M_2, and another, large and distinct, betwen Cu_1 and Cu_2, the two ocelli separated by a prominent white subapical band. There are two orange bars across the cell. On the hindwing, the ocellus at the outer angle is large and distorted, as mentioned in the key. On the under side, the ground color is much lighter, with the markings of the upper side repeated, with the addition of various fine reddish lines on the hindwing. Length of f.w., 20–37 mm.

Met. The food plants in the United States include *Gerardia, Linaria, Ludwigia* and *Plantago.*

Dist. This is a common butterfly in the southern United States. Cuban specimens are quite constant in pattern, while those from the United States are very variable. In the M.C.Z. there are 13 specimens from Oriente, Habana and Pinar del Rio; there are specimens in the U.S.N.M. from the Isle of Pines.

68. Precis zonalis

Vanessa genoveva: Poey, 1847, p. 123; *id.*, 1852, p. 198.
Junonia lavinia: Herrich-Schäffer, 1864b, p. 163; Gundlach, 1881, p. 64.
Junonia zonalis Felder & Felder, Reise Nov., p. 399 (1867).
Junonia coenia genoveva: Holland, 1916, p. 492.
Junonia lavinia zonalis: Forbes, 1928b, p. 307.
Junonia genoveva: Holland, 1931, p. 156, pl. 20, f. 9.

The character pointed out in the key will serve to distinguish this species from the preceding, the only Cuban form with which it is apt to be confused. There are many other differences, especially in the pattern on the under side of the hindwing. Cuban specimens show little variation. The name *zonalis* (types from Colombia, Cuba, Puerto Rico) seems to be about the best available for this form; its exact status cannot be determined without revision of the genus. Length of f.w., 24–30 mm.

Met. Gundlach found the larva on a plant of the family Scrophulariaceae.

Dist. In the M.C.Z. there are 48 specimens from Oriente, Sta. Clara (Soledad) and Habana; very similar specimens are found on the other West Indian islands.

Genus XXVII. Anartia Hübner

Genotype, *Papilio jatrophae* Linnaeus.

Key to species

1. Ground color of f.w. very dark brown, with a white discal band. 70. *A. lytrea*
   Ground color of wings white, with numerous fine dark lines, the wing margins light brown or orange.....69. *A. jatrophae*

69. Anartia jatrophae jamaicensis

Vanessa jatrophae: Poey, 1847, p. 122.
Anartia jatrophae: Herrich-Schäffer, 1864b, p. 163; Gundlach, 1881, p. 59; *id.*, 1891, p. 448; Holland, 1916, p. 492.
Anartia jatrophae jamaicensis Möschler, 1886, p. 27.
Anartia jatrophae saturata: Seitz, V, p. 462 (1914).

The ground color is white, shaded with light grey, which usually covers the outer half of both wings; the outer margins are usually bordered by two rows of orange spots; there is a round black spot between veins Cu_1 and Cu_2 on the forewing, and two similar spots between M_1 and M_2, and Cu_1 and Cu_2 on the hindwing, as well as numerous dark lines. This pattern is repeated on the under side, but the fine lines are here often shaded with pink. Cuban specimens, although darker on the average than those from the continent, seem never to show the complete infuscation often seen in specimens from Hispaniola and Puerto Rico. Length of f.w., 25–30 mm.

Met. Gundlach (1891) bred this species from "Orozús" (*Lippia*).

Dist. The choromorph *jamaicensis* is found only in the Antilles and southern Florida; it is best characterized by the presence of two rows of fulvous spots on the outer margin of the forewing; in *jatrophae*, found almost everywhere on the tropical mainland, the inner row of spots is white. In the M.C.Z. there are 114 specimens from Oriente, Sta. Clara (Soledad) and Habana.

70. Anartia lytrea chrysopelea

Anartia chrysopelea Hübner, Zutr., 3rd. Hndrd., p. 34, f. 547, 548 (1825).
Vanessa chrysopelea: Poey, 1847, p. 123.
Anartia litraea: Herrich-Schäffer, 1864b, p. 163.
Anartia lytrea: Gundlach, 1881, p. 60; Holland, 1916, p. 492; Seitz, V, p. 463, pl. 94e (1914).

The forewing is dark brown, with a white band extending from the costa to vein Cu_2, and with a round black spot ringed with orange be-

tween veins Cu_2 and 2A. The hindwing is similar, with a large triangular white median spot, and a small black and orange anal spot. Both wings have a narrow orange submarginal line, and various fine dark lines on the basal area. The under side is similar to the upper. Length of f.w., 22–26 mm.

Gundlach's "*Anartia n. sp.*" (1881, p. 61) seems to be *A. lytrea lytrea* (*dominica* Skinner), known only from Hispaniola. If this also occurs in Cuba, it would seem that we are dealing with two species; the record must be confirmed, however, as Gundlach did not himself collect the specimen to which he refers.

Dist. This species is known from Cuba, the Isle of Pines, Swan Is., Hispaniola and Antigua; the choromorph on Hispaniola is *lytrea*, while that on Antigua has been described as *eurytis* by Fruhstorfer. There are 84 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Matanzas and Pinar del Rio.

Genus XXVIII. Metamorpha Hübner

Genotype, *Papilio sulpitia* Cramer.
Victorina Blanchard, genotype *Papilio stelenes* Linnaeus.

71. Metamorpha stelenes insularis

Vanessa steneles: Poey, 1847, p. 121.
Victorina steneles: Herrich-Schäffer, 1864b, p. 163; Gundlach, 1881, p. 66.
Victorina steneles lavinia: Seitz, V, p. 463 (*partim*) (1914).
Victorina steneles insularis Holland, 1916, p. 493.

This very common butterfly is distinguished from all of its Cuban fellows by the prominent bands and spots of translucent pale green; the upper side is black in ground color, the under side grey and brown. Holland's characterization of the Cuban race is not very good, but the form does seem distinct enough to warrant naming; specimens from Hispaniola and Jamaica have but one large green spot in the cell of the forewing, while those from Cuba have two. The species is very variable, especially in the markings of the under side. Length of f.w., 38–45 mm.

Met. Gundlach lists "Mazorquilla" (*Blechum*) as the food plant, but he does not describe the larva. Wolcott (1923, p. 142) has given some notes on the life history in Puerto Rico, where he found the larva on *Blechum Brownei*.

Dist. This species occurs almost everywhere in the American tropics; it is abundant in Cuba, especially along shaded trails. In the M.C.Z. there are 42 specimens from Oriente, Sta. Clara (Soledad), Habana, and the Isle of Pines; the U.S.N.M. specimens are from the Isle of Pines and Matanzas.

Genus XXIX. Athena Hübner

Genotype, *Papilio petreus* Cramer.

Marpesia Hübner, genotype *Marpesia eleuchea* Hübner.
Tymetes Boisduval, genotype *Tymetes merops* Boisduval.
Megalura Blanchard, genotype *Nymphalis coresia* Godart.

Key to species

1. Wings brown, crossed by black lines.....73. *A. eleuchea*
   Wings dark grey, crossed by lighter lines.....72. *A. chiron*

72. Athena chiron

Fig. 2, outline of wing.

Papilio chiron Fabricius, 1775, p. 452.
Nymphalis chiron: Poey, 1847, p. 47.
Timetes marius: Herrich-Schäffer, 1864b, p. 161.
Marpesia chiron: Gundlach, 1881, p. 35.
Megalura chironides Staudinger, 1886, p. 134.
Megalura chiron: Seitz, V, p. 468, pl. 96a (1921).
Athena chiron: Holland, 1931, p. 162, pl. 21, f. 4.

The wings above are usually quite dark, with four longitudinal light lines, the basal line not as clear as the others. The apex of the forewing has five or six small white spots, that may be partially or wholly obscured (*chironides* Stgr.). The under side is very variable, usually silvery white basally, grey or brown on the outer half. The tail at M_3 is well developed. The females are sometimes lighter colored than the males. Length of f.w., 28–30 mm.

Met. Gundlach found the larva on "Mora del pais" (*Chlorophora tinctoria*), which he lists as *Maclura tinctoria.*

Dist. This species occurs almost everywhere in the American tropics, but attempts to name geographical races have not been very successful. In the M.C.Z. there are 28 specimens from Oriente, Sta. Clara (Soledad) and Habana.

73. Athena eleuchea eleuchea

Marpesia eleuchea Hübner, Zutr., 1st Hndrd., p. 32, f. 197, 198, (1818); *id.*, Ex. Schm., 2, pl. 50, 4 figs. (182–); Gundlach, 1881, p. 35.
Nymphalis eleuchea: Poey, 1847, p. 47.
Timetes eleuchea: Herrich-Schäffer, 1864b, p. 161; Holland, 1916, p. 493.
Megalura eleuchea: Seitz, V, p. 470, pl. 96e (1921).

The ground color of the wings above is brown; there are four black lines across the cell of the forewing, and two more, which reach the inner margin, beyond the cell. There are similar lines on the hindwing, and some black spots with blue scaling in the anal region. The tail at M_3 is well developed, as is the anal lobe. The pattern of the under side resembles that of a dried leaf; it is quite variable. Length of f.w., 29–35 mm.

Met. Gundlach found the larva on *Ficus*.

Dist. This choromorph is limited to Cuba and the Bahamas; specimens from Hispaniola and Jamaica (*pellenis* Godt.) are less heavily marked. In the M.C.Z. there are 19 specimens from Oriente, Sta. Clara (Soledad) and Habana; the U.S.N.M. specimens are from Oriente, Matanzas and the Isle of Pines.

Genus XXX. Hypolimnas Hübner

Genotype, *Papilio pandarus* Linnaeus.

74. Hypolimnas misippus

Papilio misippus Linnaeus, 1764, p. 264.
Diadema bolina: Herrich-Schäffer, 1864b, p. 162.
Hypolimnas misippus: Gundlach, 1881, p. 42; Brooks, 1903, p. 292; Seitz, V, p. 470 (1921); Holland, 1931, p. 145, pl. 21, f. 9, 10.

The male is black, with two large white spots on the forewing, and one on the hindwing, surrounded by areas of purple reflection. The female has the *Danaus* pattern: brown, with the apex of the forewing dark, enclosing some white spots. Length of f.w., 33–40 mm.

Dist. This is a common butterfly in the tropics of the Old World; it has been taken several times, at widely scattered localities in the Antillean region. I have not seen any Cuban specimens, and I know of no authentic records except those given by Gundlach (Cárdenas and Bemba) and Brooks (Guantanamo).

Genus XXXI. Historis Hübner

Genotype, *Papilio odius* Fabricius.
Aganisthos Boisduval, genotype *Papilio odius* Fabricius.

75. Historis odius odius

Papilio odius Fabricius, 1775, p. 457.
Nymphalis orion: Poey, 1847, p. 44.
Aganisthos orion: Herrich-Schäffer, 1864b, p. 163.
Aganisthos odius: Butler, 1869, p. 54; Gundlach, 1881, p. 68, 441; Holland, 1916, p. 493.
Historis orion odius: Seitz, V, p. 471 (1921).
Aganisthos odius orion: Kaye, 1926, p. 470.

The upper side is brown, heavily bordered with black, with a single white spot in the apex of the forewing; the under side is more variegated, marked with various lines and shadings. The large size and simple pattern of this butterfly make it unmistakable. Length of f.w., 52–65 mm.

The nomenclature of this species seems quite clear. *Odius* has page precedence over *orion* in the 1775 paper of Fabricius, and therefore becomes the specific name. *Odius*, with the margin of the hindwing white, described from the "Indies," is surely the Antillean form, rather than *orion*, from "Surinam."

Met. The larva has been described by Gundlach and Kaye; it feeds on "Yagruma hembra" (*Cecropia*).

Dist. We have specimens from Hispaniola, Cuba and Jamaica, all distinct from the continental *orion* in the wider brown of the forewing, often produced to form a point above M_2, as well as in various other details. There are 2 specimens in the M.C.Z. from Oriente and Camagüey; it was seen at Soledad, but not captured. The U.S.N.M. has specimens from Oriente and the Isle of Pines.

Genus XXXII. Coea Hübner

Genotype, *Papilio acheronta* Fabricius

76. Coea acheronta

Papilio acheronta Fabricius, 1775, p. 501.
Nymphalis acheronta: Poey, 1847, p. 45.
Megistanis cadmus: Herrich-Schäffer, 1864b, p. 161.
Megistanis acheronta: Gundlach, 1881, p. 36.
Coea acheronta: Seitz, V, p. 471, pl. 104d; Holland, 1931, p. 171, pl. 60, f. 2.

This species is similar to the preceding (*H. odius*), but smaller, and with six white spots in the apex of the forewing. The under side is quite variable in the intensity and distribution of the markings. There is a short and slender tooth at vein M_3 of the hindwing. Length of f.w., 40–47 mm.

Dist. This is a common species almost everywhere in tropical America. The only evidence of geographical variation that I have seen is in our three Cuban specimens, which are slightly different from specimens from Hispaniola, Jamaica, or any that I have seen from the continent. These Cuban specimens are without precise locality, however, and it seems best not to name this possible choromorph until fresh material is available.

Genus XXXIII. Colobura Billberg

Genotype, *Papilio dirce* Linnaeus.
Gynaecia Doubleday, genotype *Papilio dirce* Linnaeus.

77. Colobura dirce

Papilio dirce Linnaeus, 1758, p. 477.
Vanessa dirce: Poey, 1847, p. 121.
Gynaecia dirce: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 48; *id.*, 1891, p. 448; Seitz, V, p. 472, pl. 79a (1921).

The upper surface is a quite uniform grey, except for the broad transverse yellow band of the forewing. The under side has a zebra-like pattern of black lines on a creamy ground. Length of f.w., 35 mm.

Met. Gundlach found the larva on *Cecropia* ("Yagruma hembra"); the statement in Seitz that it lives on *Cassia* must be a mistake, as Müller (1886, p. 27) found it also on *Cecropia* in Brazil.

Dist. This is a rather common and widespread tropical American butterfly. It is found on various West Indian islands, and Gundlach reports it as occurring over the whole island of Cuba. I have seen no Cuban specimens.

Genus XXXIV. Lucinia Hübner

Genotype, *Lucinia sida* Hübner.

78. Lucinia sida

Lucinia sida Hübner, Ex. Schm., 2, pl. 35, 4 figs. (182–); Gundlach, 1881, p. 69; Seitz, V, p. 475, pl. 97b (1914).
Nymphalis cadma: Poey, 1847, p. 49.
Lucinia cadma: Herrich-Schäffer, 1864b, p. 163; Holland, 1916, p. 492.
Lucinia sida cubana Fruhstorfer, 1912, p. 14.

The upper side is brown, with some irregular black markings on the forewing; in fresh specimens, the discal area of the hindwing shows pink reflections. On the under side, the forewing is marked as above; the hindwing, however, is white, with various brown markings and two large, compound, metallic green eyespots. Length of f.w., 19–23 mm.

Met. Gundlach found the larva on "Angarilla," or "Clavelito de sabana" (*Echites*).

Dist. This form is limited to Cuba; other forms, possibly distinct enough to be called species, occur in Jamaica and Hispaniola. Fruhstorfer's name *cubana* was based on the erroneous supposition that *sida* was described from Hispaniola. In the M.C.Z. there are 29 specimens from Oriente, Sta. Clara (Soledad) and Habana; the U.S.N.M. specimens are from Matanzas and Habana.

Genus XXXV. Eunica Hübner

Genotype, *Papilio monima* Cramer.

Key to species

1. Upper side of h.w. grey, with no purplish reflections, but with a submarginal dark wavy line, and a postdiscal row of small round dark spots between the veins . . . . . 82. *E. heraclitus*
   Upper side of h.w. immaculate, dark, or with distinct purple reflections on the disc 2
2. F.w. distinctly excavated on the outer margin just below the apex; a white spot on the upper side of this wing between veins Cu_2 and 2A, in addition to the apical spots . . . . . 79. *E. tatila*
   Outer margin of f.w. even; no white spot between veins Cu_2 and 2A 3
3. Small, f.w. less than 20 mm. long; white spots of upper side of f.w. reduced, only one or two distinct . . . . . 81. *E. fairchildi*
   Larger, f.w. more than 20 mm. long; five white spots indicated on the upper side of f.w., and at least three well developed. 80. *E. habanae*

79. Eunica tatila tatila

Cybdelis tatila Herrich-Schäffer, 1850–58, p. 54, series II, fig. 69–72.
Eunica tatila: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 50; Holland, 1931, p. 158, pl. 59, f. 29.
Eunica tatila tatila: Seitz, V, p. 484, pl. 100Aa (1915).

The forewing above is dark, with six distinct white spots in the apical half; the purplish or blue reflection usually extends well over the basal half of the wing. The under side of the forewing is dark grey, with the spots of the upper side repeated; the pattern of the hindwing is too variable to be described briefly—it is always composed of brown and grey shades, resembling the bark of the trees on which the butterfly habitually rests. Length of f.w., 25–30 mm.

Dist. The supposed differences between Central American, Floridan and Cuban specimens are difficult to find when a series is studied. Most authors have assumed that Cuba is the type locality of the name, but the original reference mentions only "Am. mer." Kaye (1926, p. 473) has described a subspecies from Jamaica, but the character that he mentions—blue instead of purple reflection—is by no means peculiar to Jamaica; I have not seen any Jamaican specimens, however. From the material studied, it would seem that one form, *tatila*, ranges over all of middle America, while one or two fairly distinct choromorphs are found in the Brazilian region. There are 14 specimens in the M.C.Z. from Oriente (Sierra Maestra); the U.S.N.M. specimens are also from Oriente (Tanamo).

80. Eunica monima habanae

Faunia orphisa: Poey, 1847, p. 178; *id.*, 1852, p. 199.
Eunica monima: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 51.
Eunica monima habanae Seitz, V, p. 485, pl. 100Ac (1915).

This species is similar to the preceding, but slightly smaller, and easily enough distinguished by the characters pointed out in the key. In some females the purple reflection is entirely lacking (the *E. monima* of Seitz), but there seems to be no correlation of this character with season. Length of f.w., 20–24 mm.

The Cuban form is very similar to that found on the continent, which I take to be the true *monima* of Cramer, subsequently named *modesta* by H. W. Bates (not the *modesta* of Seitz!). Cuban specimens are uniformly larger than continental specimens, and show a somewhat different range of variation.

Met. The larva of the Central American form was described by Dyar (1912, p. 54) under the name *Eunica modesta;* he lists *Zanthoxylum pentamon* as the food plant.

Dist. This form occurs in Cuba, Hispaniola and Florida; the species is known from Jamaica, but I have seen no specimens from there; on the mainland, *monima* is found in Central America and northern South America. In the M.C.Z. there are 34 specimens from Oriente and Sta. Clara (Soledad); the U.S.N.M. specimens are from Oriente and the Isle of Pines.

81. Eunica pusilla fairchildi subsp. nov.

Eunica pusilla: Godman & Salvin, Biologia, 1, p. 228 (1883), (*partim:* Cuba).

The upper side of both wings is uniform, dark purplish brown, except for a small indistinct white spot between R_4–$_5$ and M_1. On the under side, the pattern is very similar to that of *E. habanae.* The ground color is dark grey, with an indistinct whitish spot near the base of the M_1–M_2 area of the forewing, similar subapical spots between R_3–R_4–$_5$ and M_1, and another in about the middle of the M_3–Cu_1 area. There are some blue and purple scales near the apex of the forewing. The pattern of the hindwing is essentially like that of *habanae:* the ground color purplish, crossed by a broken sub-basal line, a similar median line, a postmedian row of four spots surrounded by grey areas, and a submarginal line. Length of f.w., 15 mm.

Pusilla is much smaller than *monima,* and the forewing seems somewhat differently shaped; I have been unable to find any genitalic differences, however, in a series of dissections of both forms from several localities. The two seem to behave as separate species populations, however. The Cuban form of *pusilla* differs from Central American and Colombian specimens in being darker, with the markings of the under side heavier, especially the lines of the hindwing and the blue scaling in the apex of the forewing. I have seen no Amazonian specimens (the type locality of *pusilla*) but the Cuban form does not agree very well with the original description and figure.

Dist. The type is a single male from La Milpa, Cienfuegos Bay, Sta. Clara, VIII–10–1932, Bates and Fairchild.

82. Eunica macris heraclitus

Eunica heraclitus: Herrich-Schäffer, 1864b, p. 162; Gundlach, 1881, p. 52.
Eunica macris heraclitus: Seitz, V, p. 485, pl. 100Ad (1915).

This species differs from its Cuban congeners in the lighter wing color, which shows no reflection at all, and in the other characters pointed out in the key. Length of f.w., 27 mm.

I can find no description of this species previous to that given by Gundlach (1881), hence the name is ascribed to him. The name is a *nomen nudum* in the various catalogues of Herrich-Schäffer, Kirby, and so forth; the reference to Poey, often cited, is incorrect, and I can find no Eschscholz description. The name, in this sense, does not appear in Sherborn's Index.

Dist. Macris is essentially a Brazilian insect, and I know of no Central American relatives; the Cuban form, however, seems very similar. In the M.C.Z. there are 3 specimens labelled "Cuba." Gundlach states that it is common in certain localities: near Habana, Vuelta-Abajo, Trinidad, and the Sierra Maestra to the south of Bayamo.

Genus XXXVI. Dynamine Hübner

Genotype, *Papilio mylitta* Cramer.

The nomenclature of the species of this genus seems to be in an unusually complete muddle, so that it has been impossible to be sure of the names of the two Cuban forms, although both are common and well known species.

Key to species

1. Upper side with white spots and bands (females) 2
   Upper side metallic green or blue, no white (males) 3
2. H.w. above with one broad white median band ..... 83. *D. egaea*
   H.w. above with two rather narrow white bands, one basal and one discal ..... 84. *D. mylitta*
3. F.w. above with a black patch between veins Cu_1 and Cu_2. 84. *D. mylitta*
   F.w. above immaculate green except for a dark subapical band. 83. *D. egaea*

83. Dynamine egaea zetes (?)

Nymphalis zetes Ménétriés, 1834, p. 128, pl. 11, f. 1, 2.
Nymphalis serina: Poey, 1847, p. 49; *id.*, 1852, p. 198.
Eubagis serina: Herrich-Schäffer, 1864b, p. 162.
Dynamine serina: Gundlach, 1881, p. 47.
Dynamine zetes: Röber in Seitz, V, p. 508, pl. 101Ai (1915).

The under side is largely white, in both sexes, with some brown lines and bands, and two blue-pupiled eyespots on the hindwing. Above, the sexes are very different, as pointed out in the key. Length of f.w., 18–21 mm.

Met. Gundlach found the larva on "pringa-moza" (*Platygyna hexandra*).

Dist. This species is found only on the Antilles. The type locality of *egaea* (Fabricius, 1775, p. 496; *serina, l.c.*, p. 497) is Jamaica; Cuban specimens differ from Jamaican ones both in appearance and in the structure of the male genitalia. I have been unable to examine specimens from Hispaniola (type locality of *zetes*), so I do not know whether these will agree with the Cuban specimens or not.

There are 31 specimens in the M.C.Z. from Oriente and Sta. Clara (Soledad).

84. Dynamine mylitta bipupillata

Nymphalis postverta: Poey, 1847, p. 49; *id.*, 1852, p. 198.
Eubagis postverta: Herrich-Schäffer, 1864b, p. 162.
Dynamine postverta: Gundlach, 1881, p. 46.
Dynamine mylitta ab. *bipupillata* Röber in Seitz, V, p. 507 (1915).

The forewing of the female has five or six white spots in the apical half, while *egaea* has only the broad, interrupted, median white band and two small spots near the outer margin. The male is much more heavily bordered with black above than the male of *egaea*. The under side is similar to that of the preceeding species. Length of f.w., 20 mm.

Dist. This species ranges over most of tropical America. There is only a single male in the M.C.Z., from Habana; this agrees well with specimens from northern Central America, to which I apply the name *bipupillata*. Röber published this name as an MS aberration of Staudinger's (!), without locality; we have, however, a specimen from Guatemala, typical of the Central American choromorph, purchased from Staudinger under this name, hence I assume that this was the application intended for *bipupillata*. The species is probably confined to the western end of Cuba.

Genus XXXVII. Adelpha Hübner

Genotype, *Papilio mesentina* Cramer

85. Adelpha iphicla iphimedia

Nymphalis basilea: Poey, 1847, p. 48.
Heterochroa basilea: Herrich-Schäffer, 1864b, p. 161.
Adelpha basilea: Gundlach, 1881, p. 29.
Adelpha iphicla iphimedia Fruhstorfer in Seitz, V, p. 523 (1915).
Adelpha iphicla: Holland, 1916, p. 493.

The wings above are dark grey, crossed by a broad pearly-white median band, which begins at M_3 of the forewing and almost reaches the anal angle of the hindwing. There is an orange subapical bar on the forewing, and a similar small anal spot on the hindwing. The wings are lighter on the under side, with numerous brown wavy lines; the white band of the upper side is repeated. Length of f.w., 24–31 mm.

Met. Gundlach found the larva on "Digame" (*Calycophyllum candidissimum*).

Dist. This species is found almost everywhere in the tropics of the American continent, whence Fruhstorfer has described many subspecies. The Cuban choromorph—the only one known from the Antilles—seems quite distinct from any of the continental forms. There are 25 specimens in the M.C.Z. from Oriente, and Sta. Clara (Soledad); in the U.S.N.M. there are specimens from Oriente and the Isle of Pines.

Genus XXXVIII. Doxocopa Hübner

Genotype, *Papilio agathina* Cramer.

86. Doxocopa laure druryi

Catargyria druryi Hübner, Ex. Schm., 2, pl. 63, f. 1, 2, (182–).
Nymphalis laura: Poey, 1847, p. 46.
Apatura laura: Herrich-Schäffer, 1864b, p. 163.
Apatura druryi: Gundlach, 1881, p. 61.
Chlorippe druryi: Röber in Seitz, V, p. 547, pl. 110Be (1916).

The male has the wings brown above, with a broad median orange band and a small orange apical patch on the forewing, and a narrower median white band on the hindwing. The disc of the hindwing and the base of the forewing show purple reflections. On the under side the ground color is silver, with various markings. The female is much larger, lighter in color, with a white median band on both wings, and a round, light brown subapical spot on the forewing. It resembles the male on the under side. Length of f.w., ♂ 27–28 mm.; ♀ 31–36 mm.

Met. Gundlach found the larva on "Jía" (*Cascaria*).

Dist. This species is found in most parts of tropical America; the males of *druryi*, a choromorph known only from Cuba, are similar to those of the Central American *laure*, the females are more distinct. The Central American form is reported from Jamaica, but it is apparently rare and little known there; the only species of the genus found in Hispaniola (*thoë*) is very distinct.

In the M.C.Z. there are 25 specimens from Oriente and Sta. Clara (Soledad).

Genus XXXIX. Asterocampa Röber

Genotype, *Apatura celtis* Boisduval & Leconte, by present designation.
Celtiphaga Barnes & Lindsey, genotype *Apatura celtis* Bdv. & Lec.

87. Asterocampa lycaon idyja

Doxocopa idyja Hübner, Ex. Schm., 3, pl. 9, 2 figs, (?1834); Herrich-Schäffer, 1864b, p. 163; Gundlach, 1881, p. 62.
Nymphalis idyja: Poey, 1847, p. 46.
Asterocampa lycaon idyja: Röber in Seitz, V, p. 549 (1916).

The ground color of the wings varies from dark grey to light brown. The outer margin of the forewing of the male is deeply excavated between veins M_2 and Cu_2, making the wing quite falcate: a character that is not so prominent in the female. The postmedian row of six or seven small round dark spots between the veins of the hindwing, both above and below, is perhaps the most characteristic mark of the species. Length of f.w., ♂ 27–30 mm.; ♀ 33–40 mm.

Met. Gundlach found the larva on "Agracejo de sabána" (*Ardisia cubana*); most species of the genus feed on *Celtis*.

Dist. This form seems to be limited to Cuba and Hispaniola. Fruhstorfer (1912, p. 14) separated the Hispaniolan form as a new subspecies, *padola*, but specimens from that island in the M.C.Z. fall well within the range of variation of Cuban specimens. The species occurs also in the southern United States and Central America. In the M.C.Z. there are 9 specimens from Oriente and Sta. Clara (Soledad); the U.S.N.M. has specimens from Oriente and the Isle of Pines.

Genus XL. Prepona Boisduval

Genotype, *Papilio demodice* Boisduval.

88. Prepona antimache crassina

Nymphalis demophon: Poey, 1847, p. 45.
Prepona demophoon: Herrich-Schäffer, 1862, p. 119; *id.*, 1864b, p. 161.
Prepona amphitoe: Gundlach, 1881, p. 33.
Prepona antimache crassina Fruhstorfer, 1904, p. 126; *id.*, in Seitz, V, p. 555, pl. 111c (1916).

This striking species cannot be confused with anything else found in Cuba. The wings are black, with a bright metallic blue discal band on the hindwing, continued on the forewing from the inner margin to vein Cu_1; there is also a small subapical blue patch on the forewing. The under side is grey, with various dark lines. Length of f.w., 42–47 mm.

Dist. This choromorph is limited to Cuba, but a very similar form is found in Hispaniola; the species has a wide range in the American tropics. In the M.C.Z. there are two specimens labelled "Cuba, Wright" (Oriente); the specimens in the U.S.N.M. are from Baracoa.

Genus XLI. Siderone Hübner

Genotype, *Siderone ide* Hübner.

89. Siderone nemesis nemesis

Papilio Nobilis Nemesis Illiger, 1801, p. 203.
Nymphalis ide: Poey, 1847, p. 46.
Siderone ide: Herrich-Schäffer, 1864b, p. 161; Holland, 1916, p. 493.
Siderone nemesis: Gundlach, 1881, p. 32; Röber in Seitz, V, p. 577, pl. 116b (1916).

This is another very distinctive species, unlike anything else found in Cuba. The forewing is black, with a large bright red basal patch, and a red median band; the hindwing is black, with a red costal spot. On the under side, the species has a "dead-leaf" pattern. Length of f.w., 30–37 mm.

Dist. From the material before me, it would seem that specimens from Cuba and Hispaniola differ in various ways from continental specimens, hence the name *nemesis* may be restricted to them. Some form of the genus is found in almost every part of the American tropics; whether or not they all represent one species, however, is doubtful. In the M.C.Z. there are 14 specimens from Oriente and Sta. Clara; the U.S.N.M. has specimens from Oriente and the Isle of Pines.

Genus XLII. Anaea Hübner

Genotype, *Papilio troglodyta* Fabricius.
Hypna Hübner, genotype *Papilio clytemnestra* Cramer.

Key to species

1. F.w. with a broad yellow median band; under side of h.w. with some silver spots ..... 90. *A. iphigenia*
   Not so marked 2
2. Upper side bright, with various dark lines and spots, including a submarginal row of large pale confluent spots on f.w. 91. *A. cubana*
   Upper side dark, the base of the wings sometimes reddish; usually immaculate except for some black spots at the anal angle of h.w. 92. *A. verticordia*

90. Anaea clytemnestra iphigenia

Nymphalis clytemnestra: Poey, 1847, p. 47.
Hypna clytemnestra var. *iphigenia* Lucas, 1857, p. 577; Herrich-Schäffer, 1862, p. 119; *id.*, 1864, p. 161; Gundlach, 1881, p. 33.
Hypna iphigenia: Röber in Seitz, V, p. 579, pl. 116d (1916).

The upper side is brown, with a broad yellow band and some subapical yellow spots on the forewing; the under side is mottled with brown, lavender and silver. The tail at M_3 of the hindwing is well developed, slightly spatulate. The species is not likely to be confused with anything else. Length of f.w., 40–48 mm.

Dist. This species has a wide range in the American tropics; the choromorph *iphigenia* is known only from Cuba, and the species has not been reported from any of the other West Indian islands. There are 25 specimens in the M.C.Z. from Oriente and Sta. Clara (Soledad).

91. Anaea troglodyta cubana

Nymphalis troglodyta: Poey, 1847, p. 48.
Paphia troglodyta: Herrich-Schäffer, 1864b, p. 161.
Anaea troglodyta: Gundlach, 1881, p. 30.
Perrhanaea cubana Druce, 1905, p. 549.
Anaea troglodyta cubana: Rober in Seitz, V, p. 581, pl. 117d (1916).

The base of the wings above is reddish brown, while the outer half is light brown, marked off by dark lines on the forewing. The under side is light brown, marked with innumerable small dark spots—a "bark" pattern. Length of f.w., 40–43 mm.

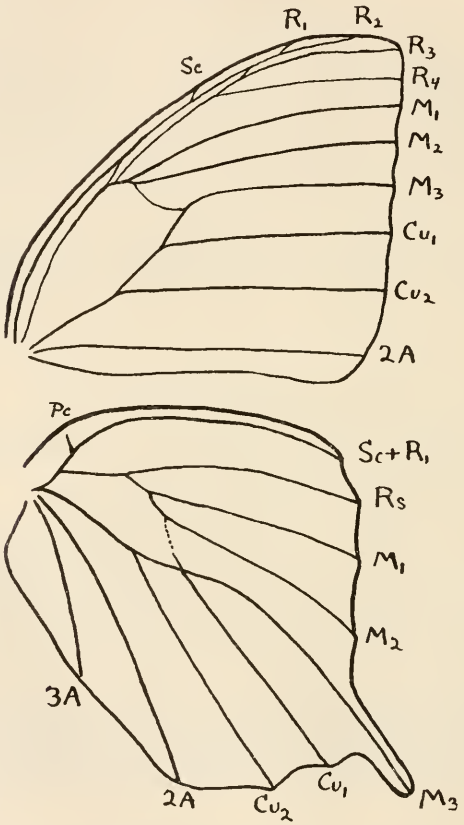

Fig. 13. *Anaea verticordia echemus*, venation.

Met. Poey found the larva on "Romero cimarron" (*Pectis*).

Dist. This form is presumably limited to Cuba; the name-type occurs in Jamaica and Hispaniola, and several choromorphs, probably belonging to this species, are found in the southern United States and

Central America. In the M.C.Z. there are 4 specimens from Oriente (Sierra Maestra, 1000 ft., Querci); the U.S.N.M. specimens are from Santiago de Cuba. Gundlach found it in the vicinity of Cienfuegos (Sta. Clara).

92. Anaea verticordia echemus

Fig. 13, venation.

Cymatogramma echemus Doubleday et al., Gen. Lep., p. 316, pl. 49, f. 4 (1850).
Megalura poeyi Lucas, 1857, p. 562.
Paphia echemus: Herrich-Schäffer, 1864b, p. 161.
Anaea echemus: Gundlach, 1881, p. 31; Röber in Seitz, V, p. 583, pl. 118d (1916).

The wings above are brown or sometimes reddish, at the base, becoming almost black toward the margins, except that the apex of the forewing is usually somewhat lighter. The under side has a finely reticulate pattern of dark brown; the hindwing is marked with two blue spots in a lighter area at the anal angle. Length of f.w., 24–30 mm.

Met. Gundlach found the larva on "Cuaba" (*Croton lucidus*).

Dist. Hübner's (Zuträge, III, p. 35, f. 559, 560) described *Anaea verticordia* from "Havannah," but the only specimen I have seen with the submarginal spots shown in his figure came from Hispaniola. The species is also known from the Bahamas and Dominica. In the M.C.Z. there are 35 specimens from Oriente and Sta. Clara (Soledad); the U.S.N.M. has specimens from Matanzas.

Family VI. LIBYTHEIDAE

Opinions as to the relationship of the Libytheids with other butterfly groups are so various that it seems best here to avoid the problem by placing them in a separate family. The extraordinary palpi, longer than the thorax, will serve to distinguish the Cuban species from anything else.

Genus XLIII. Libythea Fabricius

Genotype, *Papilio celtis* Fuessly.

93. Libythea carinenta motya

Fig. 14, venation.

Hecaërge motya Hübner, Ex. Schm., 2, pl. 137, f. 1, 2 (182–).
Libythea motya: Poey, 1847, p. 177.
Libythea terena: Herrich-Schäffer, 1864b, p. 163; Gundlach, 1881, p. 70; Kaye, 1926, p. 476.
Hypatus carinenta var. *motya:* Pagenstecher, 1901, p. 15; *id.*, 1911, p. 11.
Libythea carinenta motya: Seitz, V, p. 623, pl. 120De (1916); Hering, 1921, p. 285, pl. 2, f. 3.

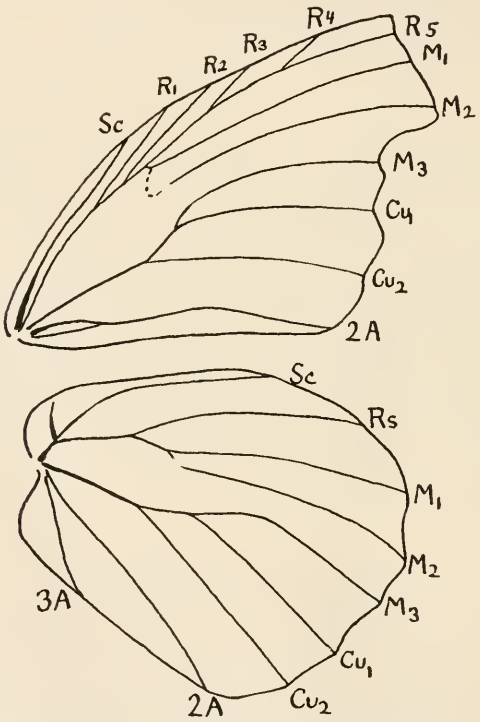

Fig. 14. *Libythea carinenta motya*, venation.

The forewing is whitish toward the inner margin, tinged with russet in the cell, with the apical half of the wing very dark brown, enclosing three white spots. The hindwing is whitish, darker on the margins. On the under side the markings of the upper side are repeated on the

forewing; the hindwing has a fine reticulate pattern. Length of f.w., 20–25 mm.

Met. The form found in the United States lives on *Celtis* in the larval stage.

Dist. This species ranges over the entire American continent, and many forms have been described. The only West Indian specimens that I have seen are from Cuba, so I do not know how widely the form *motya* may range. Kaye considers the Cuban, Hispaniolan, Puerto Rican and Jamaican specimens to be the same, and he states that the type of *terena* (Godart, 1819, p. 170, 813) came from Puerto Rico. The description of *terena* seems to fit figures 3 and 4 of Hübner's plate (*l.c.*); I have used the name *motya* for the Cuban form, basing it on figures 1 and 2, on the principle of page precedence. If the two prove to be merely extreme varieties of the same choromorph, *terena* will become the name of the Cuban form.

In the M.C.Z. there are 18 specimens from Oriente, Sta. Clara and Habana.

Family VII. RIODINIDAE

The almost total absence of this family in the Antillean region has been commented on in the introductory part of this paper. The group is a very large one, with many species in tropical America, but most of the forms seem to be rare and local.

Genus XLIV. Apodemia Felder & Felder

Genotype, *Lemonias mormo* Felder & Felder.

94. Apodemia carteri ramsdeni

Mesosemia ramsdeni Skinner, 1912, p. 126; Seitz, V, p. 727 (1920); Stichel, 1930, p. 247.

The brownish-grey ground color, the black, yellow-encircled spot at the anal angle of the hindwing above, and the very long antennae (two thirds as long as the costa of the forewing) will distinguish this from any other Cuban butterfly. The upper side of the forewing is marked with a postdiscal line of whitish spots, of which only those nearest the costa are distinct, and with several broad dark lines in the

basal half of the wing. The hindwing has several (five in the Bahaman form) dark lines, and a prominent black anal spot, ringed with yellow. The under side is lighter grey, with the markings of the upper side repeated. Length of f.w., 15 mm.

Dist. The original description of *ramsdeni* applies to specimens of *Charis carteri* Holland (1902, p. 486) from the Bahamas, except that the hindwing of Bahaman specimens above is dark orange, with dark grey lines, while Skinner describes this wing in Cuban specimens as "blackish-brown." I have not had an opportunity to compare specimens from the two localities, and the status of the names must be regarded as uncertain.

Ramsdeni was described from a pair of specimens taken at La Yberia, 20 miles from Baracoa, Sept. 18, 1909; the types are in the A.N.S.P.

Family VIII. LYCAENIDAE

The "blues" form a characteristic family, not likely to be confused with any of the other butterfly groups found in Cuba. Three or four species are very common roadside butterflies; most of the others are rather rare.

About a thousand "species" of Lycaenidae have been described from the Neotropical region, and almost nothing beyond the color pattern of the adults is known about any of them. Most of the species known from Cuba were originally described from that island, or from some other of the Antilles, so that there is little question about the application of the specific names. It has been impossible, however, to work out a system of trinomial nomenclature, such as has been used in the preceding families; only when the continental fauna has been thoroughly studied will it be possible to say whether the Cuban form should be called *Strymon martialis*, or *S. martialis martialis*, for example. The family at present, then, is of almost no use to either the zoögeographer or the student of evolution.

Key to genera

1. Antennae uniformly dark, gradually thickening toward the tip, so that there is no distinct club; abdomen entirely orange.
XLV. *Eumaeus*

Shaft of antennae ringed with white; a distinct, contrasting club present; abdomen usually grey or blue.....2

2. R_3 and R_4 stalked from cell of f.w.; h.w. without tails or filaments (Fig. 16, venation).....3
   R_4 of f.w. absent, R_3 being a simple vein; h.w. usually with delicate filamentous tails (Fig. 15, venation).....XLVI. *Strymon*
3. Eyes hairy; the cross-bars on the under side of h.w. extend over the base of the wing.....XLIX. *Leptotes*
   Eyes naked; base of f.w. immaculate beneath.....4
4. Outer margin of h.w. beneath with a row of six metallic spots; antennae somewhat more than half as long as f.w.
   XLVIII. *Brephidium*
   H.w. beneath with only two metallic spots at the anal angle; antennae less than half as long as f.w.....XLVII. *Hemiargus*

Genus XLV. Eumaeus Hübner

Genotype, *Eumaeus minyas* Hübner.

95. Eumaeus atala

Eumenia atala Poey, 1832, no. 3, 3 figs.; *id.*, 1846, p. 386; Herrich-Schäffer, 1864b, p. 165.

Eumaeus atala: Gundlach, 1881, p. 80; Holland, 1916, p. 494; Draudt in Seitz, V, p. 745, pl. 146b (1919); Holland, 1931, p. 223, pl. 28, f. 22.

This striking butterfly is much the largest of the Cuban Lycaenids. The ground color above is black, suffused with metallic bluish-green over most of the forewing and the disc of the hindwing in the male (this scaling is less extensive in the female) and with a marginal row of metallic blue spots on the hindwing. On the under side, the hindwing bears three rows of these blue spots, and a prominent orange patch on the inner margin, which matches the orange abdomen. Length of f.w., 22–24 mm.

Met. The larva lives on "Yuquilla" (*Zamia*)) and other cycads.

Dist. This form is found in Florida, the Bahamas and Cuba; it is very local, but at times extremely abundant. In the U.S.N.M. there are specimens from Oriente (Cayamas, Baracoa) and the Isle of Pines.

Genus XLVI. Strymon Hübner

Genotype, *Strymon melinus* Hübner.

This genus, like *Papilio*, is a heterogeneous assemblage of forms, in no way comparable with the other butterfly genera. The oldest

generic name for this group is *Bithys* Hübner, but as *Strymon* in the wide sense will probably be made a *nomen conservandum*, there is no point in introducing the other term here.

In addition to the species listed here, *Thecla crethona* Hewitson (Jamaica) and *Thecla telea* Hewitson (Brazil) are listed as occurring in

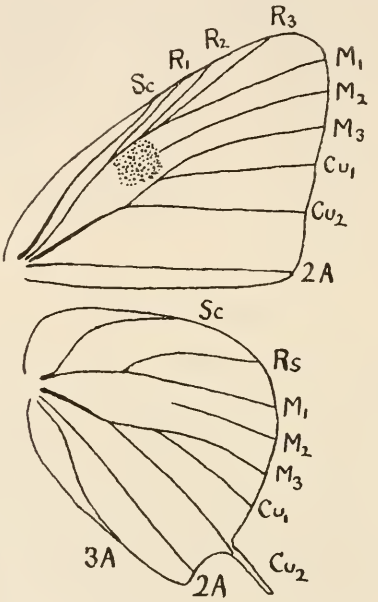

Fig. 15. *Strymon columella*, venation.

Cuba by Kaye (1926, p. 488). These species are both green below, similar to *macsites*, with which they may have been confused. The Cuban record of *Strymon tollus* (Lucas) seems to be authentic, but I have been unable to place it in the key from the meagre description; it is listed with the doubtful species at the end of the paper. Very likely thorough collecting will disclose additional species of *Strymon* on the island.

Key to species

1. Upper side of both wings with fulvous patches.....2
   Upper side not so marked—grey or blue.....3

2. F.w. beneath with two dark lines, prominently edged with white; h.w. beneath marked with red in the postmedian area. 99. *S. favonius*
   Lines of f.w. beneath not marked with white; h.w. with some yellow in the postmedian area between veins M_3 and Cu_2. 104. *S. angelia*
3. H.w. beneath with a submarginal spot of yellow, orange or red between veins Cu_1 and Cu_2, sometimes with a black pupil.....4
   H.w. beneath not so marked.....8
4. Only the tail at Cu_2 is developed; there are two definite round black spots near the costal margin of h.w. below...103. *S. columella*
   Tails are present both at Cu_2 and Cu_1; no spots on costal margin of h.w. below.....5
5. Under side of h.w. with a solid, straight black and white median bar.....6
   This bar incomplete, interrupted, or zig-zag.....7
6. H.w. and base of f.w. scaled with blue above; base of h.w. below immaculate; submarginal spot between tails black, surmounted by orange.....97. *S. martialis*
   Wings brown above, h.w. with two small white spots near base below; submarginal spot between tails reddish, irregular, without a black pupil.....98. *S. acis*
7. Under side of wings light, bluish, with several fine dark zig-zag lines.....102. *S. celida*
   Under side dark, slate grey, with a single postmedian dark line on f.w., and the two usual median and postmedian lines on h.w., interrupted on the veins.[1].....96. *S. coelebs*
8. Disc of h.w. and costal half of f.w. beneath green.....9
   No green; h.w. beneath with a brown, variegated, bark-like pattern. 105. *S. gundlachianus*
9. Postmedian line of f.w. below largely white; outer margin of h.w. bordered with brownish.....100. *S. simaethis*
   Postmedian line of f.w. below largely black; the outer margin of h.w. bordered by a definite oval spot, blue toward the margin, becoming brown toward the base, where it touches the median line.....101. *S. maesites*

[1]Some females of 104., *S. angelia*, will trace here; they may be distinguished by their smaller size, and brownish grey upper surface, with no blue scaling.

96. Strymon coelebs

Thecla coelebs Herrich-Schäffer, 1862, p. 142; *id.*, 1864b, p. 164; Hewitson, Diurn. Lep., p. 156, pl. 62, f. 416, 417 (1874); Gundlach, 1881, p. 74; Draudt in Seitz, V, p. 779, pl. 155f, g (1920).

The base of the forewing and almost the entire hindwing above are blue. On the under side, the anal mark of the hindwing is black, margined with yellow above and blue on the side; the spot between the tails is yellowish, rather faded, with only a slight indication of the black pupil. Length of f.w., 15 mm.

Met. Gundlach found the larva living in the buds of a species of *Tetrapteris* ("Bejuco de San Pedro").

Dist. This species is recorded from Cuba, Hispaniola, and Puerto Rico. In the M.C.Z. there are 3 specimens from Sta. Clara (Soledad).

97. Strymon martialis

Thecla martialis Herrich-Schäffer, 1864b, p. 164; Hewitson, Diurn. Lep., p. 156, pl. 62, f. 418, 419 (1874); Gundlach, 1881, p. 76; Holland, 1916, p. 495; Draudt in Seitz, V, p. 780, pl. 155g (1920); Holland, 1931, p. 236, pl. 30, f. 18.

Eupsyche martialis: Kaye, 1931, p. 535.

On the upper side, this species is black, with the base of the forewing and most of the hindwing blue; the anal lobe is touched with orange, and there is a small black submarginal spot between the tails. On the under side, the ground color is grey, with a white "hair-streak" on both wings. Length of f.w., 11–14 mm.

Met. In Florida, the larva has been found on *Trema micrantha.*

Dist. This species has been reported from most parts of the West Indies and Florida. In the M.C.Z. there are 2 specimens from Oriente (Sierra Maestra, 1000 ft., Querci) and Sta. Clara (Soledad). The U.S.N.M. specimens are from Habana and Santiago de Cuba.

98. strymon acis

Papilio acis Drury, 1770, p. 2, pl. 1, f. 2.

Strymon mars Hübner, Ex. Schm., 2, pl. 89, f. 1, 2, 3, 4 (182–).

Thecla acis: Draudt in Seitz, V, p. 798, pl. 158e (1920); Holland, 1931, p. 236, pl. 29, f. 38.

Eupsyche acis: Kaye, 1926, p. 490.

The wings above are brown, fringed with white; the hindwing has a small orange submarginal spot between the tails, and a touch of orange on the anal lobe. On the under side, the ground color is lighter, with the "hair-streaks" rather straight, heavily marked with white. Length of f.w., 14 mm.

Dist. This species has been recorded from Florida, Cuba, Jamaica and Dominica. I have seen no Cuban specimens.

99. Strymon favonius

Papilio favonius Abbot and Smith, 1797, p. 27, pl. 14.
Thecla favonius: Holland, 1916, p. 495; Draudt in Seitz, V, p. 798, pl. 158e (1920); Holland, 1931, p. 238, pl. 29, f. 22.

The ground color above is brown, with an irregular patch of orange about in the center of the forewing, and a similar submarginal patch near the anal angle of the hindwing. On the under side the ground color is similar, with two more or less broken, fine, black and white "hair-streaks" on each wing. Length of f.w., 16 mm.

Met. In the United States the larva has been found on oaks (*Quercus*).

Dist. Holland (1916) records a single badly rubbed specimen of this species from the Isle of Pines. It is common in the southern United States; I have seen no West Indian specimens, however.

100. Strymon simaethis

Papilio simaethis Drury, 1770, p. 3 pl. 1, f. 3.
Thecla simaethis: Herrich-Schäffer, 1864b, p. 165; Gundlach, 1881, p. 79; Draudt in Seitz, V, p. 798, pl. 158f (1920); Kaye, 1926, p. 488; Holland, 1931, p. 232, pl. 29, f. 39.

The upper side is uniform dark brown. On the under side, the ground color is light green, with a single, smoothly curved, white "hair-streak," thinly bordered with brownish red, on the forewing, and a similar, somewhat zig-zag, streak on the hindwing. The outer margin of the hindwing is rather broadly bordered with brown, irrorated with numerous whitish scales. Length of f.w., 11 mm.

Dist. This species is supposedly widely distributed in the American tropics, and it has been recorded from many parts of the West Indies. I have seen no Cuban specimens.

101. Strymon maesites

Thecla maesites Herrich-Schäffer, 1864b, p. 165; Gundlach, 1881, p. 80.

On the upper side, the male is largely bright blue, while the female is black, with the base of the forewing and most of the hindwing dark blue. On the under side, the ground color is green, with an interrupted black "hair-streak" on the forewing, and a similar streak on the hindwing, outwardly margined with white toward the anal angle. The oval patch, mentioned in the key, is quite distinctive. Length of f.w., 11 mm.

Dist. Gundlach reports this species from Cuba and Puerto Rico. In the M.C.Z. there is a specimen from Oriente (Sierra Maestra, 1000 ft., Nov., Querci); Mr. S. C. Bruner kindly sent me a beautiful male taken in the vicinity of Habana.

102. Strymon celida

Thecla celida Lucas, 1857, p. 610; Hewitson, Diurn. Lep., p. 125, pl. 49, f. 246, 247 (1869); Gundlach, 1881, p. 79; Draudt in Seitz, V, p. 803, pl. 159b (1920); Kaye, 1931, p. 535, pl. 39, f. 10.

Thecla aeon ? : Herrich-Schäffer, 1864b, p. 165.

The upper side is blue, except for the black apical half of the forewing. On the under side, the ground color is light bluish-grey, with several fine, zig-zag, dark lines, and a small orange spot between the tails. Length of f.w., 10–12 mm.

Dist. This species has been recorded from Cuba and Jamaica. There is one specimen in the M.C.Z. from the Isle of Pines (March, W. R. Zappey), and one in the U.S.N.M. labelled "Cuba."

103. Strymon columella

Fig. 15, venation.

Papilio columella Fabricius, 1793, p. 282.

Tmolus eurytulus Hübner, Ex. Schm., 2, pl. 90, 4 figs. (182–).

Polyommatus eurytulus: Poey, 1846, p. 387.

Thecla eurytulus: Herrich-Schäffer, 1864b, p. 165.

Thecla limenia: Hewitson, Diurn. Lep., p. 160, pl. 63, f. 431, 432 (1874); Gundlach, 1881, p. 77.

Thecla cybira Hewitson, Diurn. Lep., p. 161, pl. 63, f. 435, 436 (1874); Gundlach, 1881, p. 77.

Thecla bubastus eurytulus: Draudt in Seitz, V, p. 809, pl. 145h (1920).

Callicista columella: Kaye, 1926, p. 489; *id.*, 1931, pl. 39, f. 15.

Callicista bubastus eurytulus: Kaye, 1931, p. 535, pl. 39, f. 13.

Thecla columella: Holland, 1931, p. 240, pl. 64, f. 35, 36.

The wings above are grey, with two or three dark spots at the anal angle of the hindwing, surrounded by blue scaling, which may cover most of this wing in the female. The under side is lighter grey, with three rows of small submarginal light spots, the inner row edged with black. The Cu_1–Cu_2 spot of the hindwing is black, surmounted by orange. Length of f.w., 11–14 mm.

I can find no grounds for recognizing more than one species among the collection of names given above—all based on West Indian specimens. In general, the names *eurytulus* and *cybira* have been used for females, *columella* and *limenia* for males, although the color characters used by various authors do not always split clearly on this line.

Dist. Specimens from Cuba, Hispaniola, Jamaica, the Bahamas and Florida seem to belong to the same form. The species has been reported from almost every part of the American tropics. In the M.C.Z. there are 102 specimens from Oriente, Sta. Clara (Soledad) and Habana.

104. Strymon angelia

Thecla hugo: Herrich-Schäffer, 1862, p. 142; *id.*, 1864b, p. 165.
Thecla angelia Hewitson, Diurn. Lep., p. 162, pl. 63, f. 439, 440 (1874); Gundlach, 1881, p. 78; Draudt in Seitz, V, p. 809, pl. 145i (1920).
Calycopis angelia: Kaye, 1931, p. 535, pl. 39, f. 12.

The upper side of both wings in the male is light reddish brown, bordered with darker brown; the light brown is less extensive and duller in the female, sometimes entirely absent. On the under side the ground color is brown, with two dark "hair-streaks" on both wings. The basal (postdiscal) streak on the hindwing is bordered exteriorly with white; the spot between the tails is largely black, bordered with yellow. Length of f.w., 9–12 mm.

Dist. This species is known from Jamaica and Cuba. In the M.C.Z. there are 11 specimens from Oriente and Sta. Clara (Soledad); in the U.S.N.M. there are specimens from Oriente and Matanzas.

105. Strymon gundlachianus sp. nov.

Thecla sp.: Gundlach, 1881, p. 441.

The forewing above is very dark, immaculate except for the stigma of the male; the hindwing is blue, except for the dark costal margin, and three or four dark spots between the veins on the outer margin. This blue scaling is less extensive in the female than in the male. On the under side, the forewing is grey, immaculate except for two wavy light lines near the outer margin; the hindwing is mottled with grey

and brown, forming a "bark" pattern, very different from the type of pattern found in the other Cuban species of the genus. Length of f.w., 10–11 mm.

This butterfly is closely related to the South American forms described as *bazochii* by Godart (1819, p. 681, Brazil); *thius* by Geyer (1832, Zutr., 4th Hndrd., p. 33, f. 743, 744, Brazil); *agra* by Hewitson (1873, Diurn. Lep., 3, p. 147, f. 369, 370, Amazon); and *infrequens* by Weeks (1901, Ent. News, 12, p. 265, Bolivia). These were all considered to be synonymous by Draudt (1920, in Seitz, V, p. 810, pl. 145i, k), but it seems to me that some at least will apply to distinct races. The Cuban form differs from all of these in having the upper side of the hindwing blue, not lavender; in that the subapical line of the forewing does not extend below M_3, although the submarginal line is complete along the outer margin; and in the intensity and details of the pattern of the under side of the hindwing.

Dist. I have not seen specimens from Hispaniola, whence Hall (1925, p. 189) recorded a species of this group as *Thecla bazochii*, and our only specimen from Jamaica, whence Kaye (1926, p. 490) recorded the species as *Callipsyche thius*, is too poor to tell whether it is the same as the Cuban form or not. Type and eight paratypes in the M.C.Z. from Oriente (Sierra Maestra, 1000 ft., June, July, Sept., Nov., Dec. collected by Querci).

Genus XLVII. Hemiargus Hübner

Genotype, *Papilio hanno* Stoll.

Key to species

1. Two blue-encircled black spots in the anal region of the hindwing below, of approximately equal size, the one between Cu_1 and Cu_2 surmounted by a prominent orange patch.....107. *H. ammon*
   Only the spot between Cu_1 and Cu_2 is developed; it is surrounded by a thin ring of yellow.....106. *H. filenus*

106. Hemiargus filenus

Fig. 16, venation.

Polyommatus filenus Poey, 1832, no. 13, 3 figs.; *id.*, 1846, p. 388; *id.*, 1852, p. 197 (as *philenus*).

Lycaena hanno: Lucas, 1857, p. 614; Holland 1916, p. 495; Holland, 1931, p. 270, pl. 32, f. 3.

Lycaena filenus: Herrich-Schäffer, 1864b, p. 164.

Cupido hanno: Gundlach, 1881, p. 71.

The male is entirely lilac-blue above, the outer margins thinly bordered with fuscous. The female is almost entirely dark, with only a touch of blue at the wing bases. On the under side the sexes are similar: grey, with darker spots, usually ringed with light grey. Length of f.w., 8–11 mm.

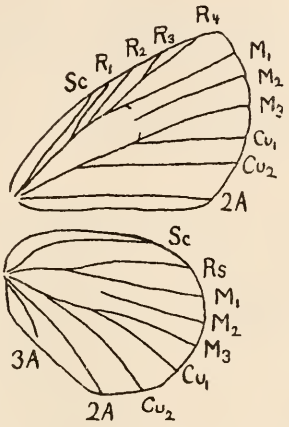

Fig. 16. *Hemiargus filenus*, venation.

Dist. West Indian specimens seem to be more heavily marked on the under side than specimens from the mainland, so I have retained the name *filenus* for this form, although it is probably at most but a choromorph of the continental *hanno* (Stoll, 1790, p. 170, pl. 39, f. 2, 2b). Specimens from Florida, the Bahamas, Cuba, Hispaniola and Jamaica seem to be the same.

In the M.C.Z. there are 87 specimens from Oriente, Sta. Clara (Soledad) and Habana.

107. Hemiargus ammon

Lycaena ammon Lucas, 1857, p. 612, pl. 16, f. 7, 7a, 7b; Herrich-Schäffer, 1864b, p. 164; Holland, 1916, p. 495.
Cupido ammon: Gundlach, 1881, p. 72.
Hemiargus ammon: Draudt in Seitz, V, p. 820, pl. 144k (1921).

Both sexes are largely blue above, but the females are more heavily bordered with black than the males, and are more variable. The two black spots of the under side are repeated above on the hindwing, as

is the spot of orange mentioned in the key. On the under side, this species is much like the preceding, but the markings are heavier, more contrasting. Length of f.w., 10–12 mm.

Met. Gundlach found the larva on "Brasilete" (*Caesalpinia*).

Dist. This form is found in Cuba and Hispaniola. Florida specimens differ somewhat from Cuban ones, and the corresponding Jamaican form (*dominica* Mösch., ? *catalina* Fabr.) is quite distinct. In the M.C.Z. there are 25 specimens from Oriente and Habana.

Genus XLVIII. Brephidium Scudder

Genotype, *Lycaena exilis* Boisduval.

108. Brephidium isophthalma

Lycaena isophthalma Herrich-Schäffer, 1862, p. 141; *id.*, 1864b, p. 164; Holland, 1931, p. 272, pl. 32, f. 4.
Cupido isophthalma: Gundlach, 1881, p. 74.
Brephidium isophthalma: Draudt in Seitz, V, p. 820, pl. 144k (1921).

This is the smallest Cuban butterfly. The wings are dark above, blue toward the base. On the under side, the ground color is grey, with numerous short white lines, forming chain patterns. The row of metallic spots on the outer margin of the hindwing is quite distinctive. Length of f.w., 7 mm.

Dist. This form is known from Cuba, Florida and the Bahamas. In the M.C.Z. there are 4 specimens from Oriente ("Cuba, Wright"); I have seen specimens from Habana, collected by Mr. S. C. Bruner.

Genus XLIX. Leptotes Scudder

Genotype, *Lycaena theonus* Lucas.

109. Leptotes theonus

Polyommatus cassius: Poey, 1846, p. 387.
Lycaena theonus Lucas, 1857, p. 611, pl. 16, f. 8, 8a, 8b; Holland, 1916, p. 495; Holland, 1931, p. 272, pl. 32, f. 6.
Lycaena cassius: Herrich-Schäffer, 1864b, p. 164.
Cupido cassius: Gundlach, 1881, p. 73.
Leptotes theonus: Draudt in Seitz, V, p. 820, pl. 144l (1921).

The male is entirely lilac-blue above, with the dark markings of the under side showing through; the wings of the female are rather heavily

bordered with dark grey, and only the bases show blue reflections, the discal area of both wings being light grey. The under side is similar in the two sexes; the ground color is white, with various grey lines and spots, and with two black, blue-margined spots near the anal angle of the hindwing, the M_2–M_3 spot being much the larger. Length of f.w., 9–13 mm.

Dist. The exact range of this form cannot be determined from the material at hand; Jamaican, Cuban and Floridan specimens seem very similar, and probably Hispaniolan specimens will agree with these. *Theonus* is probably a choromorph of the South American *cassius*. In the M.C.Z. there are 77 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Family IX. HESPERIIDAE

The skippers form a well defined and easily recognized group of butterflies. They are usually rather small and dull, and in consequence they have been undeservedly neglected by most students of Lepidoptera. Almost no general work has been done on the metamorphosis of the family, and it is perhaps partly on this account that their classification is in a very confused state.

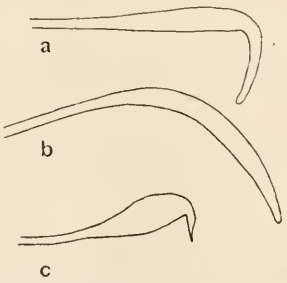

Fig. 17. Antennae of Hesperiidae: a, *Polygonus lividus;* b, *Achlyodes papinianus;* c, *Atalopedes mesogramma.*

Skinner and Ramsden (1924) have published a list of the Cuban species of the family and Williams (1931) has given additional notes on many of the forms. The order of species and nomenclature adopted here follows that of Lindsey, Bell and Williams (1931) as far as possible; Mr. E. L. Bell kindly looked over my manuscript, making many valuable suggestions.

Key to genera

1. Vein M_2 of f.w. not curved at base, usually about intermediate between M_1 and M_3 (Figs 18–21); mid tibiae without spines; males often with a costal fold (stippled area in fig. 21), never with a stigma. (*Pyrginae*) 2

   Vein M_2 of f.w. curved at base, arising nearer to M_3 (Figs. 22–24), or if straight, the mid tibiae are spined; males often with a stigma on f.w. (stippled area in figs. 22, 24), never with a costal fold. (*Hesperiinae*) 10

2. H.w. with a long tail ..... LI. *Goniurus*

   H.w. not tailed; at most lobed 3

3. Antennal club hooked, the recurved part differentiated from the rest in form or color, forming an apiculus. (Fig. 17a) 4

   Antennal club evenly rounded, not hooked. (Fig. 17b) 8

4. Discocellular vein of f.w. between M_3 and M_2 very long and curved—more than twice as long as the vein between M_2 and M_1; under side of h.w. purplish black, with some blue lines. L. *Phocides*

   Lower discocellular of f.w. not so long; no bright blue spots or lines on under side of h.w. 5

5. Dorsum of thorax fuscous, concolorous with wings; outer margin of h.w. slightly lobed at veins M_3 and Cu_1, not lobed at the anal veins ..... LV. *Cabares*

   Dorsum of thorax usually with some green, blue or orange hairs; outer margin of h.w. evenly rounded, or lobed at the anal angle 6

6. F.w. with three small subapical spots and three large discal spots, the discal spots forming a triangle. (Fig. 18, venation.) LIII. *Polygonus*

   F.w. immaculate, or with a discal row of four or more spots; never with only three separated spots in this area 7

7. Body and base of wings above with orange or fulvous scales, or discal area of under side of h.w. with silvery white markings. LII. *Proteides*

   Body and base of wings above with green or blue scaling, or at least a few greenish hairs on thorax; no white markings in discal area of h.w. below ..... LIV. *Telegonus*

8. Club of antenna long, slender, not distinctly flattened, less than twice as thick as shaft (fig. 17b); outer margin of f.w. excavated at R_1 (fig. 20) ..... LVI. *Achlyodes*

   Club of antenna twice as thick as shaft, at least in one direction; outer margin of f.w. evenly rounded 9

9. Upper side of both wings checkered with white spots. LXI. *Pyrgus*
   Upper side, at least of h.w., entirely dark. (Genera LVII to LX.) Key to species under ..... LVII. *Ephyriades*
10. Apiculus of antennae prominent, about as long as the club is thick, or longer 16
    Apiculus shorter than thickness of club, or absent, (In case of doubt, try both alternatives.) 11
11. Club blunt, without an apiculus; abdomen projecting considerably beyond wing margins ..... LXII. *Ancyloxypha*
    Club with an apiculus; body about even with outer margin of wings 12
12. Antennae very short, scarcely longer than width of thorax; apiculus reduced to a minute point ..... LXIV. *Hylephila*
    Antennae longer; apiculus discernable with unaided eye 13
13. Under side of h.w. with a prominent median white or yellow band, perpendicular to the costa; male stigma large and thick. (Fig. 17c, antenna; 22, venation.) ..... LXV. *Atalopedes*
    No such band on h.w.; male stigma long and narrow or absent ... 14
14. Dark, fuscous species, with white spots on f.w.; no stigma in male. LXXI. *Lerodea*
    Ochraceous or fulvous species; no white spots on wings; stigma present in male 15
15. Under side of h.w. bright, ochraceous ..... LXIII. *Adopaea*
    Under side of h.w. dark, greyish, with scattered yellow scales; a discal row of light spots usually indicated ..... LXVI. *Polites*
16. Antennae less than half as long as f.w. 17
    Antennae half as long as f.w. or longer 21
17. F.w. apically produced, the outer margin in part concave; no stigma in male; f.w. usually with several—6 or 7—prominent white spots. (Fig. 23, venation.) 18
    F.w. with outer margin convex; stigma sometimes present; when white spots are present on f.w. they are usually only four in number and not strongly developed 19
18. H.w. with three prominent white spots on disc above; mid tibiae spinose ..... LXXII. *Calpodes*
    No white spots on h.w. above; mid tibiae without spines. LXXIII. *Prenes*
19. Large insects (f.w. 20 mm. or longer), wings dark orange, with heavy brown borders; no stigma in male; third joint of palpus prominent, projecting nearly 1 mm. beyond vestiture of second joint ..... LXX. *Phemiades*

Smaller species, f.w. less than 20 mm. long; ground color of wings dark; 3rd joint of palpus not so prominent; male with stigma . 20

20. Stigma of male complex, with a band of modified scales extending to the inner angle of f.w.; spots of f.w. in females ochraceous; under side of palpus grey, sometimes with a green tinge LXVII. *Catia*

Stigma of male a black bar extending between veins 2A and the fork of M_3 and Cu_1; spots on f.w., if present, white; under side of palpus orange or yellow ..... LXIX. *Lerema*

21. Ground color of wings ochraceous; veins of h.w. prominently outlined with yellow beneath ..... LXVIII. *Poanes*

Ground color fuscous or dark grey; under side of h.w. not marked on the veins 22

22. F.w. with no light spots 23

F.w. with various light or translucent spots 24

23. 3rd joint of palpus long and erect; small and slender species. LXXVII. *Godmania*

3rd joint of palpus small, hidden in vestiture of 2nd joint; large, strong species ..... LXXIV. *Asbolis*

24. Cell of h.w. open 25

Cell of h.w. closed 26

25. F.w. with a large spot across middle of cell; other spots of f.w. large and prominent ..... LXXVI. *Paracarystus*

Spots of f.w. small, indistinct; cell spot rarely present, at most a minute light dot ..... LXXI. *Lerodea*

26. H.w. immaculate above; male with an elongate, curved stigma on f.w. (Fig. 24, venation.) ..... LXXV. *Perichares*

H.w. with two or three translucent spots on disc; no stigma in male ..... LXXVIII. *Thracides*

Genus L. Phocides Hübner

Genotype, *Phocides cruentus* Hübner.

110. Phocides batabano batabano

Eudamus batabano Lucas, 1857, p. 624.

Erycides mancinus Herrich-Schäffer, 1862, p. 143.

Erycides, batabano: Herrich-Schäffer, 1865, p. 56; Gundlach, 1881, p. 171.

Phocides batabano: Holland, 1916, p. 501; Draudt in Seitz, V, p. 851, pl. 165d (1921); Skinner & Ramsden, 1924, p. 308; Williams, 1931, p. 307; Shepard, 1931, p. 7.

This is a large black or dark purple butterfly, marked on the upper and under side of the hindwing with a variable amount of blue-green in the form of incomplete lines; this wing is distinctly lobed. There are several rows of small bluish green spots on the under side of the body; the palpi are white beneath. Length of f.w., 27–30 mm.

Met. The larva has been found on mangrove (*Rhizophora mangle*) in Florida.

Dist. This form is limited to Cuba; specimens from Florida and the Bahamas belong to a distinct choromorph. The U.S.N.M. has specimens from Oriente (Tanamo) and the Isle of Pines; there are specimens in the Bell collection from Oriente (Santiago de Cuba).

Genus LI. Goniurus Hübner

Genotype, *Papilio proteus* Linnaeus.
Eudamus Swainson, genotype *Papilio proteus* Linn.

Key to species

1. Upper side of body and base of wings clothed with long green hairs ..... 113. *G. proteus*
   No such green vestiture 2
2. H.w. underneath with whitish zig-zag lines, giving a sort of marbled appearance ..... 111. *G. marmorosa*
   Under side lacking this whitish ..... 112. *G. santiago*

111. Goniurus marmorosa

Goniurus marmorosa Herrich-Schäffer, 1865, p. 56; Gundlach, 1881, p. 171; Shepard, 1931, p. 29.
Eudamus marmorosa: Skinner & Ramsden, 1924, p. 308; Draudt in Seitz, V, p. 938 (1924) (mention).

"This is a very rare species. Above, it looks much like *santiago*, but the spots are more yellowish, and more lustrous; the two spots nearest the inner margin are nearer one another; the isolated spot is triangular (the base of the triangle forward). Underneath one sees, besides the blackish bands, whitish zig-zag lines, or patterns. Expanse, 38 mm." (Gundlach, 1881).

Met. Gundlach found a pupa on the leaves of "Guara" (*Cupania americana*).

Dist. Gundlach found the species only in the neighborhood of Habana; it seems not to have been captured in recent years. The only specimens that I have seen are some from the Poey collection, now in the A.N.S.P.

112. Goniurus dorantes santiago

Eudamus santiago Lucas, 1857, p. 623; Holland, 1916, p. 500, pl. 31, f. 6; Skinner & Ramsden, 1924, pl. 308; Draudt in Seitz, V, p. 853, pl. 161a (1921); Williams, 1931, p. 307.
Goniurus cariosa Herrich-Schäffer, 1862, p. 142.
Goniurus santiago: Herrich-Schäffer, 1865, p. 56; Gundlach, 1881, p. 170.
Goniurus corydon Butler, 1870b, p. 492; *id.*, Lep. Ex., p. 65, pl. 25, f. 2 (1871).
Goniurus dorantes var. *santiago:* Shepard, 1931, p. 20.

This species is dark brown above, somewhat lighter near the bases of the wings, immaculate except for a few small translucent yellowish spots on the forewing. The under side of the hindwing, which is somewhat variable, is crossed by two irregular dark bands; the outer margin is often greyish. Length of f.w., 19–22 mm.

Dist. This species is found almost everywhere in the American tropics; there seems to be some confusion about the choromorphs in the West Indies; apparently *santiago* is the form in Cuba, the Bahamas and Hispaniola. There are 36 specimens in the M.C.Z. from Oriente, Sta. Clara (Soledad) and Habana. The U.S.N.M. specimens are from Oriente, Matanzas and the Isle of Pines.

113. Goniurus proteus

Papilio proteus Linnaeus, 1758, p. 484.
Hesperia proteus: Poey, 1847, p. 244.
Goniurus proteus: Herrich-Schäffer, 1865, p. 56; Gundlach, 1881, p. 169; Shepard, 1931, p. 14.
Edamus proteus: Holland, 1916, p. 500; Skinner & Ramsden, 1924, p. 308; Draudt in Seitz, V, p. 853, pl. 160b (1921); Williams, 1931, p. 307; Holland, 1931, p. 331, pl. 45, f. 6.

This striking skipper may be easily distinguished from anything else found in the West Indies by the green color of the body and base of the wings above, and the long tails. Length of f.w., 19–25 mm.

Met. The larva has often been described, as it is a pest of cultivated beans in many countries; it is likely to be found on almost any of the Leguminosae. Gundlach bred it from "Conchitas" (*Clitorea*) and "Marrullero" (*Phaseolus*) in Cuba.

Dist. This species is abundant almost everywhere in the American tropics. In the M.C.Z. there are 31 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Genus LII. Proteides Hübner

Genotype, *Papilio mercurius* Fabricius.
Epargyreus Hübner, genotype *Papilio tityrus* Fabricius.

Key to species

1. Segments of abdomen narrowly bordered with white on the caudal margins ..... 116. *P. sanantonio*
   Abdomen above uniform brown 2
2. Wings above with a discal band of golden yellow spots ..... 115. *P. asander*
   Wings above uniform brown except for the basal lighter brown hairs, a narrow white fringe, and two tiny subapical spots and a similar costal spot, both or either of which may be absent ..... 114. *P. maysi*

114. Proteides exadeus maysi

Eudamus maysi Lucas, 1857, p. 627.
Goniloba egeus Herrich-Schäffer, 1862, p. 142.
Goniloba maysi: Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 156.
Epargyreus maysi: Holland, 1916, p. 501, pl. 31, f. 11, 12; Skinner & Ramsden, 1924, p. 309; Draudt in Seitz, V, p. 861, pl. 166e, f (1922); Williams, 1927, p. 264; *id.*, 1931, p. 308.
Epargyreus exadeus var. *maysii:* Shepard, 1931, p. 49.

This insect is very similar to *P. sanantonio* on the upper side. The two species are quite different on the under side, but somewhat variable in both cases: in *maysi* the silvery white band on the disc of the hindwing, characteristic of the *Epargyreus* group, is represented to a varying degree, whereas in *sanantonio* the white is limited to shading on the brown markings. Length of f.w. 30–32 mm.

Dist. This species occurs almost everywhere in the tropics of continental America; the form *maysi* has been recorded only from Cuba. In the M.C.Z. there are three specimens from Oriente and the Isle of Pines.

115. Proteides asander

Eudamus asander Hewitson, 1867, Descr. Hesp., p. 9 [not seen].
Epargyreus asander: Holland, 1916, p. 502; Skinner & Ramsden, 1924, p. 309; Draudt in Seitz, V, p. 861, pl. 166f (1922).
Aguna asander: Williams, 1927, p. 288; Shepard, 1931, p. 35.

The discal band of translucent yellow spots on the forewing and the silvery white band on the under side of the hindwing will serve to distinguish this species from any of its Cuban allies. Length of f.w., 30 mm.

Dist. I have seen no Cuban specimens of this species, and I know of no record except that of Holland, from the Isle of Pines. It has also been reported from Hispaniola and Jamaica, as well as from most tropical parts of the continent, under a variety of names; the various choromorphs have never been thoroughly studied, and without specimens it is impossible to guess what form might occur in Cuba.

116. Proteides mercurius sanantonio

Eudamus sanantonio Lucas, 1857, p. 626.
Goniloba sanantonio: Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 156.
Proteides idas sanantonio: Holland, 1916, p. 502, pl. 31, f. 1, 2; Draudt in Seitz, V, p. 862, pl. 167a (1922).
Proteides sanantonio: Skinner & Ramsden, 1924, p. 309; Williams, 1931, p. 308.
Proteides mercurius sanantonio: Williams, 1927, p. 291.
Proteides mercurius var. *sanantonio:* Shepard, 1931, p. 54.

The upper side of this species repeats almost exactly the pattern of *maysi:* the thorax and base of the wings clothed with golden brown hairs, the rest of the wing surface uniform dark brown, except for one or two tiny white spots on the costal margin of the forewing. The under side is somewhat different, as described under *maysi.* Length of f.w., 27–32 mm.

Met. Kaye (1926, p. 492) found the larva of the Jamaican form on "tree-like Papilionaceae, also *Cassia.*"

Dist. This species ranges from the southern United States to the Argentine; *sanantonio* is known only from Cuba, but other choromorphs occur in Jamaica and Hispaniola. In the M.C.Z. there are 9 specimens from Oriente and Sta. Clara (Soledad); in the U.S.N.M. and in the Bell collection there are specimens from Oriente and Habana; Holland recorded it from the Isle of Pines.

Genus LIII. Polygonus Hübner

Genotype, *Polygonus lividus* Hübner.

Acolastus Scudder, type *Hesperia savigny* Latreille.
Nennius Kirby, new name for *Acolastus*, preoc.

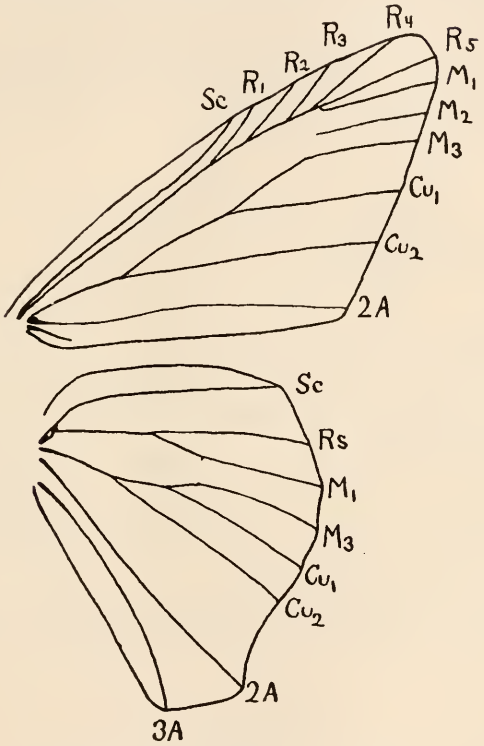

Fig. 18. *Polygonus lividus*, venation.

117. Polygonus lividus

Fig. 17a, antennal club; 18, venation.

Polygonus lividus Hübner, Ex. Schm., 2, pl. 144, 4 figs, (182–); Williams, 1927, p. 290; *id.*, 1931, p. 308; Shepard, 1931, p. 56.
Hesperia savigny: Poey, 1847, p. 245.
Goniloba savignyi: Herrich-Schäffer, 1865, p. 54.
Goniloba amyntas: Gundlach, 1881, p. 159; *id.*, 1891, p. 458.
Nennius amyntas: Holland, 1916, p. 502; Skinner & Ramsden, 1924, p. 309.
Acolastus amyntas: Draudt in Seitz, V, p. 862, pl. 146g (1922).
Polygonus amyntas: Holland,1931, p. 328, pl. 49, f. 5.

This species may be recognized by the rather uniform purplish-brown ground color of the wings above, the lobed hindwing, and the three prominent translucent white spots on the disc of the forewing. Length of f.w., 21–25 mm.

Met. Gundlach found the larva on "Guamá" (*Lonchocarpus dominguensis*); in Florida the host is *Piscidia piscipula.*

Dist. P. lividus has a wide range in the American tropics; it is found on all of the Greater Antilles. In the M.C.Z. there are 17 specimens from Oriente and Sta. Clara (Soledad); the U.S.N.M. has material from the Isle of Pines.

Genus LIV. Telegonus Hübner

Genotype, *Papilio talus* Cramér.

Key to species

1. Discal band of light spots across f.w. ..... 118. *T. talus*
   No spots on f.w. 2
2. Under side of f.w. with a bright patch of blue-green scales covering the basal half of the cell ..... 121. *T. xagua*
   No such patch; at most a few inconspicuous colored hairs at base of wing 3
3. Outer margin of h.w. on the under side broadly bordered with white. 122. *T. habana*
   No white on under side of wings 4
4. Fringe of h.w. concolorous with wing, dark brown ... 120. *T. jariba*
   This fringe, in part at least, yellowish or whitish .... 119. *T. cubanus*

118. Telegonus talus

Papilio talus Cramer, Pap. Ex., 2, p. 122, pl. 176, f. D (1777).
Hesperia talus: Poey, 1847, p. 244.
Eudamus sumadue Lucas, 1857, p. 625.
Goniloba talus: Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 158.
Goniurus talus: Skinner & Ramsden, 1924, p. 309; Draudt in Seitz, V, p. 860, pl. 166d (1922).
Telegonus talus: Williams, 1927, p. 268, f. 7; *id.*, 1931, p. 309; Shepard, 1931, p. 58.

This species is easily distinguished from its Cuban relatives by the distinctly green vestiture of the body and basal part of the wings—

a coloration strikingly similar to that of *G. proteus*. The forewing is crossed obliquely by a row of five translucent yellow spots. Length of f.w., 25 mm.

Met. Gundlach found the larva on "Yamao" (*Guarea guara*).

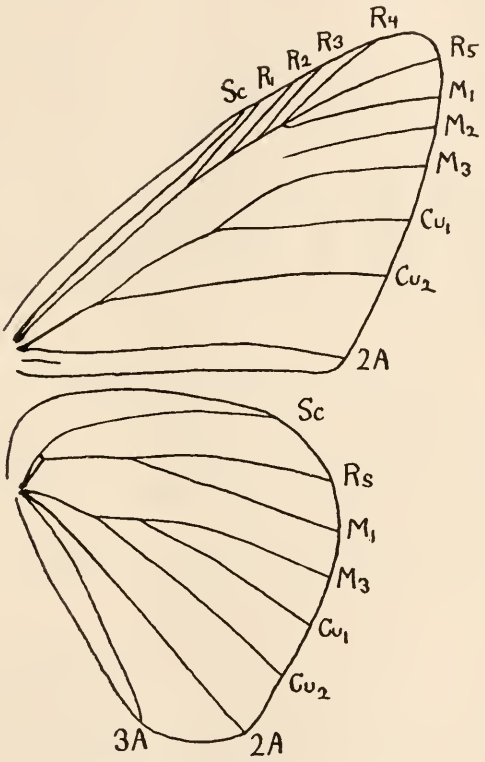

Fig. 19. *Telegonus alardus habana*, venation.

Dist. This species ranges from Mexico to Brazil on the continent, and it has been reported from all of the islands of the Greater Antilles; no choromorphs have been described, and our material is insufficient to determine whether any exist. In the M.C.Z. there is one specimen from Sta. Clara (Soledad); in the U.S.N.M. and in the Bell collection there are specimens from Oriente.

119. Telegonus anaphus cubanus

Telegonus alpistus var. *cubana* Mabille & Boullet, 1912, p. 77; Skinner & Ramsden, 1924, p. 310.
Telegonus alpistus cubana: Draudt in Seitz, V, p. 863 (1922).
Telegonus cubana: Williams, 1927, p. 281, pl. 24, f. 5; *id.*, 1931, p. 308; Shepard, 1931, p. 63.

The thorax and base of the hindwing are clothed with olive green hairs; otherwise the wings are immaculate, fuscous; the fringe of the hindwing is light, contrasting with the ground color. On the under side there is a faint pattern, composed mostly of scattered yellow scales. Length of f.w., 28 mm.

Dist. This species has a wide range in the American tropics; *cubanus* has been recorded from Cuba, Jamaica, Hispaniola and St. Thomas. In the M.C.Z. there is a single specimen, labelled "Cuba;" there are three specimens in the U.S.N.M. from Oriente (Alto del Cedro, Santiago).

120. Telegonus jariba jariba

Achlyodes cassander: Herrich-Schäffer, 1865, p. 52.
Aethilla jariba Butler, 1870b, p. 496; *id.*, Lep. Ex., p. 111, pl. 40, f. 3 (1872).
Goniloba cassander: Gundlach, 1881, p. 155.
Thymele vespasius var. *cassander:* Gundlach, 1881b, p. 113.
Telegonus geronae Holland, 1916, p. 503.
Telegonus jariba: Skinner & Ramsden, 1924, p. 311; Draudt in Seitz, V, p. 863 (1922); Williams, 1927, p. 281; *id.*, 1931, p. 309; Shepard, 1931, p. 65.
Telegonus vespasius: Shepard, 1931, p. 70 (*partim*).

This species is similar to *cubanus*, but the blue scaling on the wings is confined to a few hairs at the base of the forewing, which may be absent. The thorax is clothed with dark blue scales, sometimes almost black. The under side is very dark, almost immaculate except that the apex of the forewing of the female is sharply set off, darker. Length of f.w., 28–31 mm.

Dist. The bibliography of this species seems to be particularly complicated. I do not see how the Fabrician name *vespasius* (1793, p. 334) can apply, as yellow spots in the apex of the forewing are mentioned in the original description; the name, in any event, was based on a Jones drawing, and the West Indian material available to Jones seems always to have come from Jamaica. It is probable that the various Cuban records of *hahneli* Staudinger (Ex. Tagf., p. 291, 1888) apply to this species.

This choromorph is confined to Cuba; another has been described by Williams from Jamaica. In the M.C.Z. there are three specimens: a male from the Gundlach collection, a female from the Doll collection, which matches Butler's figure nicely, and a male apparently received by Weeks from Staudinger, under the name *hahneli;* all are labelled "Cuba." Specimens in the U.S.N.M. and the Bell collection are from Oriente (Jagua, Alto del Cedro, Santiago).

121. Telegonus xagua

Eudamus xagua Lucas, 1857, p. 627.
Goniloba malefida Herrich-Schäffer, 1862, p. 142.
Goniloba jagua: Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 157.
Telegonus xagua: Skinner & Ramsden, 1924, p. 310; Draudt in Seitz, V, p. 864, pl. 167d (1922); Williams, 1927, p. 282, f. 26, pl. 24, f. 7; *id.*, 1931, p. 308; Shepard, 1931, p. 65.

The thorax and base of the wings above are clothed with brilliant metallic blue scales; there is a similar patch on the base of the forewing below. The under side of the hindwing is immaculate, while in the next species (*habana*), the outer margin of this wing is bordered with white. Length of f.w., 24–28 mm.

Dist. This species is known only from Cuba. There are three specimens in the M.C.Z. from Oriente.

122. Telegonus alardus habana

Fig. 19, venation.

Eudamus habana Lucas, 1857, p. 624.
Goniloba habana: Herrich-Schäffer, 1865, p. 54; Gundlach, 1881, p. 158; *id.*, 1891, p. 457.
Telegonus habana: Holland, 1916, p. 503; Draudt in Seitz, V, p. 864, pl. 167d (1922); Skinner & Ramsden, 1924, p. 310; Williams, 1927, p. 284, f. 27; *id.*, 1931, p. 308; Shepard, 1931, p. 65.

This beautiful insect may be easily recognized by the blue scaling over the basal half of the wings above, the white fringe, and the white border of the hindwing on the under side. Length of f.w., 26–32 mm.

Met. Gundlach found the larva on "piñon" (*Erythrina*).

Dist. This species is found from Bolivia to Mexico on the continent, and in Cuba and Hispaniola. The choromorph *habana* is limited to Cuba. In the M.C.Z. there are 22 specimens from Oriente and Sta. Clara (Soledad).

Genus LV. Cabares Godman & Salvin

Genotype, *Thanaos potrillo* Lucas.

123. Cabares potrillo potrillo

Thanaos potrillo Lucas, 1857, p. 641.
Nisoniades potrerillo: Herrich-Schäffer, 1864b, p. 172; Gundlach, 1881, p. 141; *id.*, 1891, p. 456.
Cabares potrillo: Godman & Salvin, Biologia, 2, p. 337, pl. 80, f. 24, 25, 26 (1894); Skinner & Ramsden, 1924, p. 313; Draudt in Seitz, V, p. 878, pl. 170f (1922); Holland, 1931, p. 338, pl. 50, f. 10; Williams, 1931, p. 309; Shepard, 1931, p. 118.

The wings are brown, the forewing with two well developed subapical spots, and a discal row of six spots, of which the third from the costa is curiously shaped like an L; the fifth and sixth spots are somewhat separated from the others, the fifth being much the largest of all. The hindwing is slightly lobed at veins M_3 and Cu_1. Length of f.w., 17–20 mm.

Met. Gundlach (1891) described the larva, but failed to mention the food plant.

Dist. This species ranges over Central America, the West Indies and northern South America; specimens from the last region have been described as a distinct subspecies. In the M.C.Z. there are 2 specimens from Oriente.

Genus LVI. Achlyodes Hübner

Genotype, *Papilio busirus* Cramer.
Eantis Boisduval, genotype *Urbanus thraso* Hübner.

124. Achlyodes thraso papinianus

Fig. 20, venation.

Hesperia papinianus Poey, 1832, no. 4, 7 figs.; *id.*, 1847, p. 246.
Achlyodes papinianus: Herrich-Schäffer, 1865, p. 52; Gundlach, 1881, p. 145; *id.*, 1891, p. 457.
Eantis papinianus: Skinner & Ramsden, 1924, p. 314; Draudt in Seitz, V, p. 902, pl. 176c (1922); Williams, 1931, p. 311.

This is a rather large, dark brown species, marked with spots and lines of lighter brown. It is easily distinguished from the other Cuban skippers by the very convex outer margin of the forewing, the entire absence of white spots on the wings, and the prominent area of bluish scales on the outer margin of the under side of the hindwing. Length of f.w., 20–25 mm.

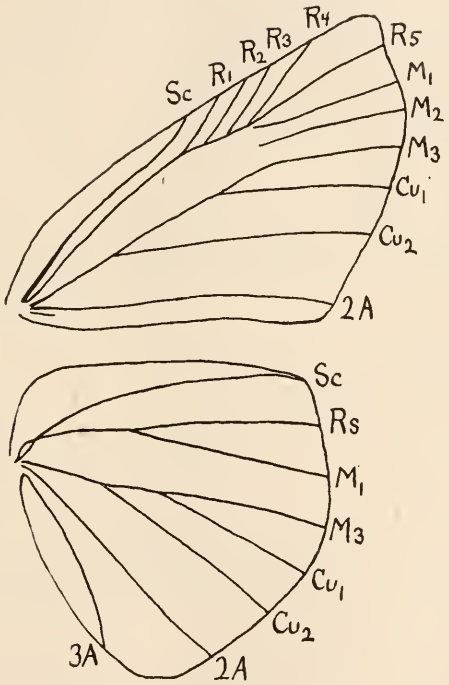

Fig. 20. *Achlyodes thraso papinianus*, venation.

Met. Poey figured the early stages, which were also described by Gundlach. The larva lives on "Ayúa" (*Zanthoxylum*) and probably also on *Citrus*.

Dist. This species is found from Texas to Paraguay on the continent, and on all of the islands of the West Indies. The choromorph *papinianus* seems to be limited to Cuba, although it has been reported

from other islands in the literature. In the M.C.Z. there are 9 specimens from Oriente; the U.S.N.M. specimens are from Oriente and Pinar del Rio.

Genus LVII. Ephyriades Hübner

Genotype, *Papilio otreus* Cramer.

The species of this and the following three genera are somewhat difficult to distinguish, hence the Cuban forms have all been placed in the following key which, based as it is on superficial characters, may serve to facilitate their identification. The Cuban populations are not sufficiently well known to permit an analysis of their specific relationships with exotic choromorphs.

Key to species of Ephyriades, Pholisora, Chiomara, Erynnis

1. F.w. with a uniform dark velvety ground color 2
   F.w. somewhat mottled, with lighter and darker areas 6
2. Six or seven small white spots forming a sort of circle near the apex of f.w. ..... 125. *Eph. zephodes*
   F.w. immaculate, or with spots otherwise arranged 3
3. F.w. above with three small distinct subapical white spots, and with two others in the median area ..... 127. *Eph. cubensis*
   F.w. with no distinct spots, although the subapical ones may be indicated 4
4. Palpi below light grey ..... 129. *P. braco*
   Palpi dark 5
5. F.w. immaculate, velvety, with a purplish cast ..... 126. *Eph. arcas*
   Two tiny subapical light spots indicated on f.w.; no purple cast to wings ..... 128. *P. concolor*
6. Palpi light grey beneath 7
   Palpi dark, not contrastingly colored 8
7. F.w. with three subapical white spots above, and an additional small spot between Cu_1 and M_3. ..... 129. *P. braco*
   F.w. with nine or ten white spots in apical region above, including one or two in cell ..... 125. *Eph. zephodes*
8. F.w. with no indication of subapical white spots ..... 130. *C. mithrax*
   Subapical spots at least indicated 9
9. Subapical spots distinct, usually four in number, or at least three ..... 132. *Er. zarucco*
   Subapical spots indistinct, never more than two present. ..... 131. *Er. gesta*

125. Ephyriades zephodes zephodes

Oileides zephodes Hübner, Ex. Schm., 2, pl. 151, 4 figs. (182–).
Hesperia zephodes: Poey, 1847, p. 246.
Nisoniades brunnea Herrich-Schäffer, 1864b, p. 172; Gundlach, 1881, p. 142.
Melanthes otreus var. *brunnea:* Holland, 1916, p. 504, pl. 31, f. 3, 4, 5.
Melanthes zephodes: Draudt in Seitz, V, p. 918, pl. 178i (1923).
Ephyriades brunnea: Skinner & Williams, 1923, p. 302.
Ephyriades otreus: Skinner & Ramsden, 1924, p. 312; Shepard, 1931, p. 119.
Ephyriades zephodes: Williams, 1931, p. 309; Shepard, 1931, p. 120.
Melanthes brunnea: Holland, 1931, p. 348, pl. 50, f. 40, 41.

The male is uniform velvety dark brown above, except for a circle of tiny white subapical spots on the forewing. The female is more variegated, the subapical spots are larger, and there is an additional, elongate, spot between Cu_1 and Cu_2. Length of f.w., 18–21 mm.

Dist. This form occurs in Florida, the Bahamas, Cuba and Hispaniola; the Jamaican choromorph is distinct. In the M.C.Z. there are 10 specimens from Oriente and Sta. Clara (Soledad); the U.S.N.M. has specimens from Habana.

126. Ephyriades arcas

Papilio arcas Drury, 1773, [p. 38], index, pl. 19, f. 5, 6.
Hesperia philemon: Poey, 1847, p. 246.
Antigonus flyas: Herrich-Schäffer, 1865, p. 52.
Antigonus arcas: Gundlach, 1881, p. 147.
Brachycoryne arcas: Skinner & Ramsden, 1924, p. 312; Wolcott, 1924, p. 149; Draudt in Seitz, V, p. 918, pl. 178i (1923).
Ephyriades arcas: Williams, 1931, p. 309, f. 1; Shepard, 1931, p. 121.

The male of *arcas* is very easily distinguished from all other Cuban Hesperiidae by its immaculate, velvety, dark brown upper side, usually with a purple cast. The male of *Pholisora braco,* which is similar, lacks the purple, and has the subapical spots at least indicated. Opinions differ about the female of this species; it may be indistinguishable from the female of *zephodes*, or it may be the form known as *cubensis*. Length of f.w., 18–22 mm.

Met. Gundlach stated that "the larva lives on Clavelito de Sabana (*Echites*), but it will probably live also on other species of Apocynaceae, as it is found in places where *Echites* does not grow." Wolcott bred this species from *Stigmatophyllum ligulatum* in Puerto Rico.

Dist. This species has been reported from various West Indian islands, and from Panama. In the M.C.Z. there is one specimen from Oriente (Torquino River).

127. Ephyriades cubensis

Ephyriades cubensis Skinner, 1913, p. 72; Skinner & Ramsden, 1924, p. 312; Williams, 1931, p. 318, pl. 27, f. 8; Shepard, 1931, p. 120.

The principal characters of this form are pointed out in the key. It is very possibly the female of *arcas*, as Williams has suggested. I have seen only the types, in the A.N.S.P., from Oriente (Yberia, twenty miles west of Baracoa, 2000 ft.). Length of f.w., 26 mm.

Genus LVIII. Pholisora Scudder

Genotype, *Papilio catullus* Fabricius.

The species of this group are included in the key under the preceding genus, *Ephyriades*.

128. Pholisora concolor

Nisoniades concolor Herrich-Schäffer, 1864b, p. 172; Gundlach, 1881, p. 144.
Bolla concolor: Skinner & Ramsden, 1924, p. 313.
Staphylus concolor: Williams, 1931, p. 317, f. 13, pl. 27, f. 2, 5.

This species looks very like the following, from which it may be most easily distinguished by the color of the palpi, which are dark, like the wing and body color, not light grey. There may be two or three subapical dots on the forewing, or these may be absent. Length of f.w., 15 mm.

Dist. This species is known only from Cuba. I have seen only the specimens in the A.N.S.P. from Oriente (Guantanamo), one of which was given to the M.C.Z.

129. Pholisora braco

Nisoniades braco Herrich-Schäffer, 1864b, p. 171; Gundlach, 1881, p. 141.
Nisoniades undulatus Herrich-Schäffer, 1864b, p. 172.
Bolla braco: Skinner & Ramsden, 1924, p. 314.
Staphyllus braco: Williams, 1931, p. 311, f. 2, pl. 27, f. 13, 15.

The male of this species is very dark, quite immaculate above except for two or three tiny subapical spots. The female is different, with the ground color of the wings much lighter, more variegated, the subapical spots (three in number) well developed, usually with a small spot between M_3 and Cu_1, sometimes with another between Cu_1 and Cu_2. It may be easily distinguished from the *Erynnis* females by the white under side of the palpi. Length of f.w., 17–19 mm.

Dist. Apparently *braco* is found only in Cuba. In the M.C.Z. there are three specimens from Oriente (Torquino River) and Sta. Clara (Soledad); the U.S.N.M. has specimens from Oriente (Baracoa) and Matanzas.

Genus LIX. Chiomara Godman & Salvin

Genotype, *Achlyodes mithrax* Möschler.

The single Cuban species is included in the key under genus LVII, *Ephyriades*.

130. Chiomara mithrax

Achlyodes mithrax Möschler, 1878, p. 225.
Cyclogypha gundlachi Skinner & Ramsden, 1924, p. 314.
Chiomara mithrax: Draudt in Seitz, V, p. 913, pl. 177i (1923); Williams, 1931, p. 317.

This species may be distinguished from the other small, dark brown Cuban skippers by the two distinct velvety brown lines that cross its forewing: one, consisting of four partly distinct spots, starts at the lower third of the costa, runs almost straight to the inner margin; the other starts at a point about two thirds of the way out on the costal margin, curves outward, then back, to end on the inner margin at its outer third. Length of f.w., 17 mm.

Dist. This species ranges from Mexico to Brazil on the continent; it is only known from Cuba in the West Indies. The only Cuban specimen I have seen—the type of *gundlachi* in the A.N.S.P. from Guantanamo (Oriente)—differs from specimens from northern South America in only a few minor respects. Without more material it is impossible to be sure whether the Cuban population should be recognized as distinct or not.

Genus LX. Erynnis Schrank

Genotype, *Papilio tages* Linnaeus.

The species are included in the key under genus LVII, *Ephyriades*.

131. Erynnis gesta

Thanaos gesta Herrich-Schäffer, 1863, p. 142; Holland, 1931, p. 349, pl. 51, f. 1, 2.
Achlyodes gesta: Herrich-Schäffer, 1865, p. 52.
Nisoniades gesta: Gundlach, 1881, p. 145; *id.*, 1891, p. 456.
Chiomara gesta: Draudt in Seitz, V, p. 913, pl. 178a (1923); Skinner & Ramsden, 1924, p. 315.
Erynnis gesta: Williams, 1931, p. 312.

The forewing above presents a variegated pattern of different shades of dark brown; two minute subapical spots are usually present on the costa, often clearer on the under side than on the upper. Length of f.w., 14–17 mm.

Met. Gundlach (1891) found the larva on "añil" (*Indigofera*).

Dist. This species ranges from Mexico to Brazil on the continent, and it has been found on all of the Greater Antilles; no choromorphs have been recognized. In the M.C.Z. there are 20 specimens from Oriente and Sta. Clara (Soledad).

132. Erynnis zarucco

Fig. 21, venation.

Thanaos zarucco Lucas, 1857, p. 641; Herrich-Schäffer, 1863, p. 140; Skinner & Ramsden, 1924, p. 314.
Nisoniades juvenalis: Herrich-Schäffer, 1864b, p. 172.
Nisoniades jaruco: Gundlach, 1881, p. 143.
Thanaos terentius: Holland, 1931, p. 354, pl. 48, f. 3.
Erynnis zarucco: Williams, 1931, p. 311.

The number of white spots on the upper side of the forewing is variable; the hindwing is immaculate fuscous above, although some marginal light spots are often indicated on the under side. The insect has a very distinctive habitus, and there is little likelihood of its being confused with any other Cuban species. Length of f.w., 20 mm.

Met. Gundlach described the larva, which he found on an exotic legume, *Sesbanea grandiflora*.

Dist. This species is found in Cuba and in the southern United States. In the M.C.Z. there are 9 specimens from Oriente and Sta. Clara (Soledad); there are specimens in the U.S.N.M. and in the Bell collection from Oriente, Matanzas and Pinar del Rio.

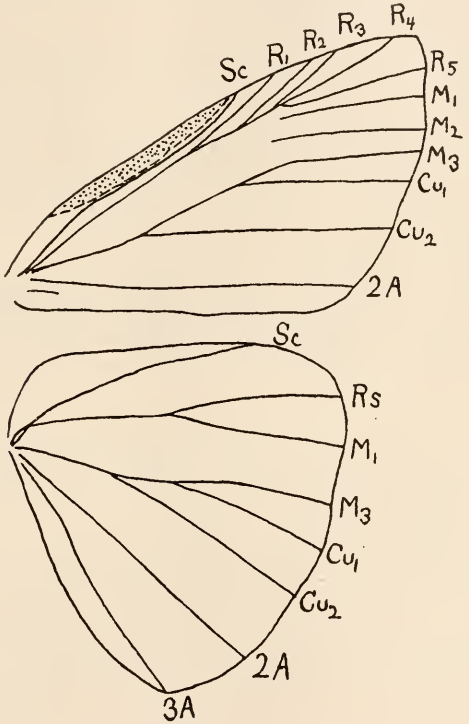

Fig. 21. *Erynnis zarucco*, venation.

Genus LXI. Pyrgus Hübner

Genotype, *Papilio syrichtus* Fabricius.

Key to species

1. White spots on wings well separated, small, rounded..134. *P. crisia*
   White spots large, for the most part rectangular, tending to form definite bands of contiguous spots.....133. *P. syrichtus*

133. Pyrgus syrichtus

Papilio syrichtus Fabricius, 1775, p. 534.
Hesperia syrichtus: Poey, 1847, p. 246; Holland, 1916, p. 506; Draudt in Seitz, V, p. 918, pl. 178k (1923); Skinner & Ramsden, 1924, p. 315; Holland, 1931, p. 341, pl. 50, f. 16, 17.
Pyrgus orcus: Herrich-Schäffer, 1864b, p. 171.
Pyrgus syrichtus: Gundlach, 1881, p. 139; Williams, 1931, p. 312.

The males have the base of the wings clothed with long whitish hairs, giving them a much lighter appearance than that of the females. As Williams has pointed out, the species varies in the coloring of the under side, depending on the season. Length of f.w., 12–16 mm.

Met. Gundlach and others have bred this species from *Sida*, a common Malvaceous weed.

Dist. This is an exceedingly common species almost everywhere in the American tropics; it probably occurs in suitable places on all of the West Indian islands. In the M.C.Z. there are 33 specimens from Oriente, Sta. Clara (Soledad), Habana and the Isle of Pines.

134. Pyrgus crisia

Pyrgus crisia Herrich-Schäffer, 1864b, p. 171; Gundlach, 1881, p. 140; Williams, 1931, p. 312, pl. 27, f. 7, 9.
Hesperia crisia: Skinner & Ramsden, 1924, p. 315.

This little skipper is easily distinguished from the common *syrichtus* by its smaller size, and the general effect of black with small white spots—in *syrichtus* the white predominates. Length of f.w., 11 mm.

Dist. Crisia has been recorded from Cuba, Hispaniola and Puerto Rico. In Cuba it is rare and local. In the M.C.Z. there are two specimens from Oriente (Sierra Maestra, 1000 ft. Querci); the U.S.N.M. specimens are from Oriente (Santiago) and Habana.

Genus LXII. Ancyloxypha Felder

Genotype, *Hesperia numitor* Fabricius.

135. Ancyloxypha nanus

Thymelicus nanus Herrich-Schäffer, 1865, p. 52; Gundlach, 1881, p. 148.
Ancyloxypha nanus: Holland, 1916, p. 506; Draudt in Seitz, V, p. 928, pl. 180d (1923); Skinner & Ramsden, 1924, p. 316; Williams, 1931, p. 318, pl. 27, f. 14.

This is the smallest Cuban skipper, easily distinguished from any other species by the under side of the hindwing, which is yellowish, with the veins prominently outlined in black. Length of f.w., 8–9 mm.

Dist. This species is known only from Cuba. Gundlach records it from Pinar del Rio (San Cristóbal), Matanzas (Colon) and Oriente (Bayamo); Ramsden found it abundantly at Mayari, in Oriente, at 1500 ft.; and Holland has listed it from the Isle of Pines. There are two specimens in the M.C.Z. from Sta. Clara (near the coast, on Cienfuegos Bay); the U.S.N.M. has specimens from Baracoa (Oriente).

Genus LXIII. Adopaea Billberg

Genotype, *Papilio thaumas* Hufnagel.

136. Adopaea magdalia

Pamphila magdalia Herrich-Schäffer, 1863, p. 143; *id.*, 1865, p. 53; Gundlach, 1881, p. 153.
Adopaea magdalia: Skinner & Ramsden, 1924, p. 316; Williams, 1931, p. 313.
Thymelicus magdalia: Draudt in Seitz, V, p. 932, pl. 181b (1924).

The ground color of both wings is bright ochraceous, with the veins outlined to a varying degree by dark brown. The outer margin of the forewing and the costal margin of the hindwing are rather heavily margined with brown, which also forms a narrow border on the outer margin of the hindwing. The sexes are similar except that the male has a narrow oblique stigma, which extends between veins 2A and Cu_1, and that the female has the veins somewhat more strongly marked with brown, and the brown wing borders wider. Length of f.w., 9–11 mm.

Dist. This species is known from Cuba and Hispaniola. In the M.C.Z. there are 24 specimens from Oriente and Habana.

Genus LXIV. Hylephila Billberg

Genotype, *Papilio phyleus* Drury.

137. Hylephila phyleus

Papilio phyleus Drury, 1770, 1, [p. 25], index, pl. 13, f. 4, 5, [1773].
Hesperia phylaeus: Poey, 1847, p. 245.
Pamphila phyleus: Herrich-Schäffer, 1865, p. 53.
Pamphila philacus: Gundlach, 1881, p. 150.
Hylephila phylaeus: Holland, 1916, p. 507; Draudt in Seitz, V, p. 928, pl. 180e (1923); Skinner & Ramsden, 1924, p. 316; Williams, 1931, p. 312; Holland, 1931, p. 377, pl. 46, f. 18, 19, pl. 47, f. 40.

The sexes of this species are somewhat differently marked. The male is ochraceous above, with brown indentations between the vein endings on the borders of both wings, and with a brown subapical spot on the forewing, and another surrounding the stigma. The stigma itself is oblique, slightly curved, narrow, extending between veins 2A and Cu_1. The female is brown above, with ochraceous spots: three small subapical spots, and others of varying size across the disc of the forewing. The hindwing also has a discal row of spots, not clearly defined. A dark brown area between the two anal veins on the under side of the hindwing is characteristic of both sexes. Length of f.w., 15–17 mm.

Met. In the United States the larva lives on various grasses, such as *Panicum*.

Dist. This insect ranges over a large part of temperate and tropical America; it is common almost everywhere within its range. It is polychoromorphic, but the various forms have not as yet been carefully worked out; specimens from the Greater Antilles are very similar to those from the Leeward Islands, whence came Drury's types. In the M.C.Z. there are 29 specimens from Oriente, Camagüey, Sta. Clara (Soledad) and Habana.

Genus LXV. Atalopedes Scudder

Genotype, *Hesperia huron* Edwards.

138. Atalopedes mesogramma

Fig. 17c, antennal club; 22, venation.

Hesperia mesogramma Latreille, *in* Godart, 1819, p. 765; Poey, 1832, no. 14, 3 figs.; *id.*, 1847, p. 245.
Hesperia alameda Lucas, 1857, p. 649.
Hesperia cunaxa Hewitson, 1866, p. 488.
Pamphila alameda: Gundlach, 1881, p. 148.
Atalopedes cunaxa: Holland, 1916, p. 507, pl. 31, f. 14.
Atalopedes mesogramma: Skinner & Ramsden, 1924, p. 316; Draudt in Seitz, V, p. 931, pl. 180l (1924); Riley, 1926b, p. 239; Williams, 1931, p. 313.

This species may be at once distinguished from all other Cuban skippers by the distinct white or light yellow band of the under side of the hindwing, which extends from vein Sc, to which it is perpendicular, to 2A. The ground color of the wings is brown, with ochraceous spots in the male, which tend to become white in the female, at least

on the forewing. The stigma of the male is broad at the base, between veins Cu_2 and 2A, tapering to end in a point at the fork of veins Cu_1 and M_3. Length of f.w., 17–20 mm.

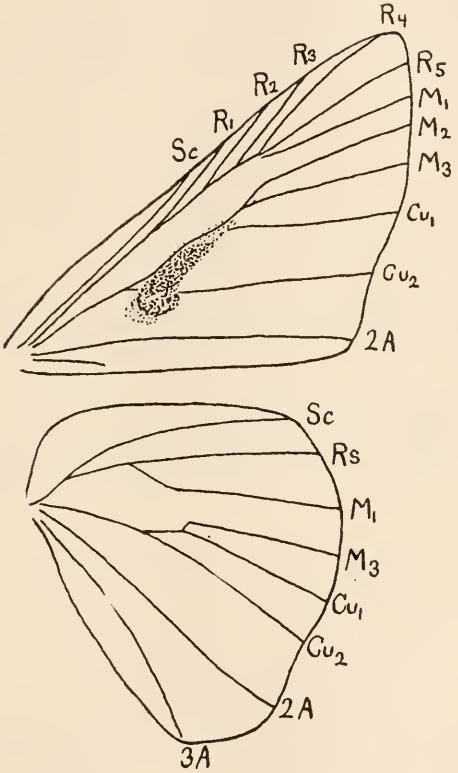

Fig. 22. *Atalopedes mesogramma*, venation.

Dist. This form is probably limited to Cuba and Hispaniola. In the M.C.Z. there are 25 specimens from Oriente, Camagüey, Sta. Clara (Soledad) and Habana.

Genus LXVI. Polites Scudder

Genotype, *Hesperia peckius* Kirby.

139. Polites baracoa

Hesperia baracoa Lucas, 1857, p. 650.
Pamphila amadis Herrich-Schäffer, 1863, p. 142; *id.*, 1865, p. 53.
Pamphila baracoa: Gundlach, 1881, p. 152.
Limochores baracoa: Holland, 1916, p. 507, pl. 31, f. 15.
Polites baracoa: Skinner & Ramsden, 1924, p. 316; Draudt in Seitz, V, p. 932, pl. 181d (1924); Holland, 1931, p. 381, pl. 53, f. 21, 22; Williams, 1931, p. 313.
Talides baracoa: Lindsey, Bell & Williams, 1931, p. 100.

The ground color of the wings is brownish. The costal margin of the forewing, from the base to beyond the end of the cell, is ochraceous, as is a row of four spots that extends from the inner margin to the tip of the cell in the female; in the male these spots become fused to form an ochraceous area covering most of the disc of the wing. The under side is similar, except that the hindwing may have a discal row of spots, usually only faintly indicated in the male. Length of f.w., 10–12 mm.

Dist. This form is found in Florida, Cuba and Hispaniola; it may be a choromorph of the North American *themistocles*. In the M.C.Z. there are 52 specimens from Oriente, Camagüey, Sta. Clara (Soledad) and Habana.

Genus LXVII. Catia Godman

Genotype, *Hesperia drury* Latreille.

140. Catia misera

Hesperia misera Lucas, 1857, p. 649.
Pamphila mago Herrich-Schäffer, 1863, p. 143; *id.*, 1865, p. 53.
Pamphila misera: Gundlach, 1881, p. 153.
Catia misera: Holland, 1916, p. 507; Skinner & Ramsden, 1924, p. 317; Draudt in Seitz, V, p. 933, pl. 181e (1924); Williams, 1931, p. 315.

The male of this species is easily distinguished from any other Cuban skipper by the stigma and scent patch, described in the key to genera. The female resembles the female of *Lerodea tripuncta* somewhat, but it differs in having the spots of the forewing ochraceous, and in having no trace of a band on the underside of the hindwing. The under side of the head and thorax in both sexes tends to be greenish. Length of f.w., 13–14 mm.

Dist. *Misera* has been reported only from Cuba and the Bahamas. Some form of the genus occurs on every Antillean island, but the three principle forms, *misera*, *vesuria* and *gemma*, seem sufficiently distinct to be called "species." In the M.C.Z. there are 39 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Genus LXVIII. Poanes Scudder

Genotype, *Hesperia massasoit* Scudder.

141. Poanes radians

Hesperia radians Lucas, 1857, p. 650; Herrich-Schäffer, 1863, p. 140.
Pamphila radians: Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 151.
?Hesperia ammonia Plötz, 1883, p. 201; Godman, 1907, p. 144.
Hesperia magica Plötz, 1883, p. 202; Godman, 1907, p. 144.
Choranthus radians: Skinner, 1920c, p. 186; Skinner & Ramsden, 1924, p. 319; Draudt in Seitz, V, p. 941, pl. 182h (1924); Holland, 1931, p. 370, pl. 51, f. 47; Williams, 1931, p. 315, pl. 27, f. 1, 3, 4, 6.
Choranthus radians f. *bellus* Draudt in Seitz, V, p. 941, pl. 182k (1924).
Poanes radians: Lindsey, Bell & Williams, 1931, p. 113.

This little species may always be distinguished from any of the other Cuban forms by the under side of the hindwing which, in both sexes, is grey, with the veins prominently outlined in greenish-yellow, and with an orange area between veins 2A and Cu_2. The male on the upper side is very similar to *Adopaea magdalia:* ochraceous, bordered with brown, with a narrow, linear stigma, extending from vein 2A to Cu_1 on the forewing. The female is larger, with heavier borders, and with the base of the forewing covered to a variable extent with brown. Length of f.w., 13–14 mm.

Dist. The only specimens of this species that I have seen are from Cuba; it has been reported from Florida, and similar forms, possibly choromorphs of this species, have been described from Hispaniola and St. Thomas. In the M.C.Z. there are 20 specimens from Oriente and Sta. Clara (Soledad).

Genus LXIX. Lerema Scudder

Genotype, *Papilio accius* Abbot & Smith.

142. Lerema cornelius

Hesperia cornelius Latreille, in Godart, 1819, p. 764; Poey, 1847, p. 245; Lucas, 1857, p. 648.
Goniloba cornelius: Herrich-Schäffer, 1865, p. 55; Gundlach, 1881, p. 167.
Amblyscirtes insulae-pinorum Holland, 1916, p. 508, pl. 31, f. 7, 8.
Lerema cornelius: Skinner & Ramsden, 1924, p. 317.
Euphyes cornelius: Riley, 1926b, p. 238.
Tigasis cornelius: Williams, 1931, p. 315.

The male is a uniform dark brown above, except for two or three inconspicuous light spots on the forewing. The stigma is large, dark, extending from vein 2A to the base of Cu_1 and M_3. The under side is brown, with a variable number of spots on the hindwing, or with this wing immaculate. The female is similar, but usually it has the markings much better developed: on the forewing above and below there are two subapical spots, a large spot between Cu_1 and M_3, and another between Cu_2 and Cu_1. On the under side of the hindwing there is a discal row of white spots, although these tend to become obsolescent in some specimens. The palpi of both sexes are orange. Length of f.w., 16–19 mm.

Dist. This form has been found only in Cuba and the Bahamas. In the M.C.Z. there are 7 specimens from Oriente and Sta. Clara (Soledad).

Genus LXX. Phemiades Hübner

Genotype, *Papilio phineus* Cramer.

143. Phemiades antiqua antiqua

Pamphila antiqua Herrich-Schäffer, 1863, p. 142; *id.*, 1865, p. 53; Gundlach, 1881, p. 150.
Phemiades antiqua: Holland, 1916, p. 509, pl. 31, f. 10; Lindsey, Bell & Williams, 1931, p. 125.
Pyrrhocalles antiqua: Skinner & Ramsden, 1924, p. 318; Draudt in Seitz, V, p. 947, pl. 183f, g (1924); Williams, 1931, p. 315.
Pyrrhocalles orientis Skinner, 1920b, p. 152; Skinner & Ramsden, 1924, p. 319.

This striking species cannot be confused with anything else in the Cuban fauna. It is a large insect, with the basal and discal areas of the wings orange, broadly bordered with dark brown. The under side of the hindwing is ferrugineous, with markings faintly indicated. Length of f.w. (Haitian specimens), 23–24 mm.; (specimens from Oriente, Cuba), 20 mm.

Dist. The descriptions of Herrich-Schäffer and Gundlach apply to a large form with a row of ochraceous subapical spots on the forewing; the specimens on which these descriptions were based came from western Cuba. All of the specimens that I have seen from Hispaniola agree very well with this description, but the Cuban specimens studied are smaller and lack the subapical spots, agreeing with Skinner's description of *orientis*. I have seen no specimens from Pinar del Rio, and it may well be that specimens corresponding to the description of *antiqua* are found there, and that there are thus two choromorphs of this species on the island of Cuba. Jamaican specimens belong to a distinct choromorph. I have not seen the original description of *Hesperia utha* Hewitson (Descr. Hesp., 1868, p. 37), but the name is usually considered to be a synonym of *antiqua*.

In the M.C.Z. there are two specimens of this species from Oriente ("Cuba, Wright," presumably from the Sierra de Yateras), and a series from Hispaniola. The U.S.N.M. specimens are from Baracoa, Tanamo, Santiago (all Oriente) and the Isle of Pines: all agreeing with the form *orientis*.

Genus LXXI. Lerodea Scudder

Genotype, *Papilio accius* Abbot & Smith.

144. Lerodea eufala

Hesperia eufala Edwards, 1869, p. 311.
Cobalus dispersus Gundlach, 1881, p. 154.
Lerodea eufala: Holland, 1916, p. 508; Skinner & Ramsden, 1924, p. 317; Holland, 1931, p. 396, pl. 46, f. 33; Williams, 1931, p. 313; Lindsey, Bell & Williams, 1931, p. 134.

The under side of the palpus is white, of the thorax and abdomen white or light grey. The ground color of the wings is lighter than that of *tripuncta*, and the spots of the forewing are all white, never infuscated. Length of f.w., 12–13 mm.

Dist. This form is credited with a wide range in tropical and temperate America; our material, however, seems to indicate that the species is polychoromorphic. Cuban specimens agree very well with topotypical specimens from Florida, so the name *eufala* may safely be applied. The species has been recorded only from Cuba and Hispaniola in the West Indies.

In the M.C.Z. there are 12 specimens from Oriente, Sta. Clara (Soledad) and Habana.

145. Lerodea tripuncta

Cobalus tripunctus Herrich-Schäffer, 1865, p. 53; Gundlach, 1881, p. 154.
Lerodea tripuncta: Holland, 1916, p. 508; Skinner & Ramsden, 1924, p. 317; Lindsey, Bell & Williams, 1931, p. 134.
Megistias tripunctus: Draudt in Seitz, V, p. 974, pl. 187k (1924); Williams, 1931, p. 313.

The wings are fuscous, the forewing with three very small subapical spots, and two slightly larger discal spots, sometimes partially infuscated or absent; the hindwing is immaculate. A discal row of small, faint spots can usually be seen on the under side of the hindwing. This species is very similar to *eufala*, but it is considerably darker. The proportionately longer antennae, which serve to separate the two species in the key to genera, form a reliable character. Length of f.w., 13–14 mm.

Dist. This is a common species in Cuba; it has been reported from Puerto Rico, and it undoubtedly also occurs in Hispaniola. Lindsey, Bell and Williams (1931) list *Megistias jamaca* of Schaus, from Jamaica, as a synonym. In the M.C.Z. there are 24 specimens from Oriente, Sta. Clara (Soledad) and Habana.

Genus LXXII. Calpodes Hübner

Genotype, *Papilio ethlius* Cramer.

146. Calpodes ethlius

Papilio ethlius Cramer, Pap. Ex., 4, p. 212, pl. 392, f. A, B (1782).
Hesperia ethlius: Poey, 1847, p. 244.
Goniloba ethlius: Herrich-Schäffer, 1865, p. 54; Gundlach, 1881, p. 160; *id.*, 1891, p. 457.
Calpodes ethlius: Skinner & Ramsden, 1924, p. 319; Draudt in Seitz, V, p. 944, pl. 183c (1924); Holland, 1931, p. 399, pl. 45, f. 3.

This well known skipper is not likely to be confused with anything else occurring in Cuba, unless it be the rare *Thracides telegonus*, to which it bears a striking superficial resemblance. The under side of the hindwing of *ethlius*, however, is uniform light brown, except for the three translucent discal spots, whereas *telegonus* has the basal half of the wing light, sharply distinct from the dark outer half.

The sexes are similar. The ground color of the wings is brown, with various translucent white spots: on the forewing there are two small

subapical spots, a similar spot between M_3 and M_2, a larger spot between Cu_1 and M_3, a prominent spot between Cu_2 and Cu_1, and a smaller spot on 2A, as well as a spot in the cell. The hindwing has three prominent rectangular discal spots. Length of f.w., 24–26 mm.

Met. The larva lives on "Platanillo de Cuba" (*Canna*) and "sagú" (*Maranta*).

Dist. This is a common species everywhere in the American tropics, remarkably constant in pattern over its entire range; the type locality of the name is Surinam. It is crespuscular, and may be found on flowers at twilight. There are 2 specimens in the M.C.Z. from Oriente ("Cuba, Wright"); specimens were observed at Soledad, but not captured.

Genus LXXIII. Prenes Scudder

Genotype, *Hesperia panoquin* Scudder.

Key to species

1. H.w. with a broad white band on the under side . . . 151. *P. corrupta*
   H.w. with a few pale spots, or with diffuse shadings on the under side 2
2. Under side of h.w. with a row of white spots 3
   This surface immaculate, or with diffuse shadings 4
3. Under side of h.w. with only three whitish spots. 149. *P. panoquinoides*
   This wing with a row of six or seven such spots . . . . 147. *P. sylvicola*
4. Two cell spots usually present on f.w.; under side of h.w. with diffuse light shadings . . . . . 150. *P. nyctelius*
   No spots in cell of f.w.; under side of h.w. immaculate, fuscous 148. *P. ocola*

147. Prenes nero sylvicola

Fig. 23, venation.

Goniloba sylvicola Herrich-Schäffer, 1865, p. 55; Gundlach, 1881, p. 166.
Prenes sylvicola: Skinner & Ramsden, 1924, p. 320; Williams, 1931, p. 315.
Prenes nero form *sylvicola:* Draudt in Seitz, V, p. 948, pl. 183i (1924).

This is the commonest of the Cuban species of *Prenes*. It is quite variable, but it may always be distinguished by the row of small white

spots on the under side of the hindwing, which never quite disappear, and by the spot on the forewing on vein 2A, which is always well developed in addition to the usual spots on the apical half of the wing. Length of f.w., 18–20 mm.

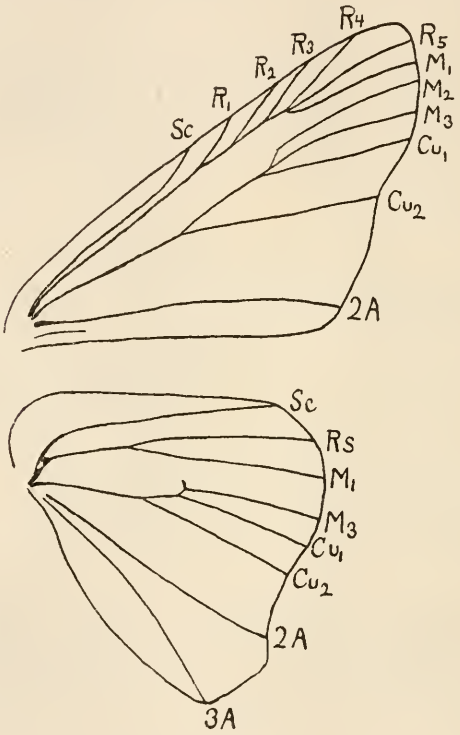

Fig. 23. *Prenes nero sylvicola*, venation.

Met. Gundlach found the larva on Para grass.

Dist. This form may occur in Florida as well as Cuba, but I have seen no Florida specimens. Hispaniola, Jamaica and other West Indian islands seem all to be inhabited by *nero*, which differs only slightly from *sylvicola*. Specimens from the continent (Central America) appear to be more like *nero* than like *sylvicola*.

148. Prenes ocola

Hesperia ocola Edwards, 1863, p. 20, pl. 11, f. 4.
Prenes ocola: Holland, 1916, p. 509; Skinner & Ramsden, 1924, p. 319; Holland, 1931, p. 398, pl. 46, f. 34, pl. 54, f. 22; Lindsey, Bell & Williams, 1931, p. 138.

This species is similar to *sylvicola*, but the band of spots on the under side of the hindwing is entirely lacking. The spot on 2A of the forewing is reduced or absent, and the other spots of this wing differ in shape in the two species. Length of f.w., 17 mm.

Dist. This species is credited with a very wide range in America. There is a specimen in the M.C.Z. from Puerto Rico, and the species will no doubt eventually be found on other West Indian islands. There is only one Cuban specimen in the M.C.Z. from Sta. Clara (Soledad); Holland has recorded it from the Isle of Pines.

149. Prenes panoquinoides

Pamphila panoquinoides Skinner, 1891, p. 175.
Prenes panoquinoides: Skinner & Ramsden, 1924, p. 319; Lindsey, Bell & Williams, 1931, p. 138.

The note in the key to species, "under side of hindwing with three whitish spots," was evidently made in the American Museum, with their Cuban specimens before me. The only specimen of the species in the M.C.Z., however, a male paratype from Texas, has no spots on the under side of the hindwing at all. The maculation of the forewing above is limited to two faint spots; below, the veins are faintly outlined with brown. Length of f.w., 12 mm.

Dist. This species was described from Florida (Key West) and Texas; there are two specimens in the A.M.N.H. from Pinar del Rio (Viñales and Cabañas).

150. Prenes nyctelius coscinia

Goniloba coscinia Herrich-Schäffer, 1865, p. 54.
Goniloba brettus: Gundlach, 1881, p. 164.
Prenes ares: Skinner & Ramsden, 1924, p. 320.
Prenes nyctelius: Riley, 1926b, p. 234; Williams, 1931, p. 316.

The forewing has two or three small subapical spots; there are almost always two small cell spots, a small spot between M_3 and Cu_1, and a larger, almost square spot between Cu_1 and Cu_2. The base of

both wings above is clothed with rather long, olive green hairs. The under side of the head and body is whitish. Most distinctive is the under side of the hindwing; the basal area is whitish, the rest brown or grey, with a light shading across the discal area, indicating the spots of *sylvicola*. Length of f.w., 17–19 mm.

Met. Gundlach found the larva on grass, especially "Pará grass."

Dist. This species is found from Mexico to southern Brazil on the mainland, and on all of the Antillean islands. It shows remarkably little geographical variation, but West Indian specimens (Cuba, Hispaniola, Jamaica, St. Croix) have the light postdiscal shading of the under side of the hindwing somewhat narrower than continental specimens, and there are other small differences in the pattern of this wing. In the M.C.Z. there are 9 specimens from Oriente, Sta. Clara (Soledad) and Habana.

151. Prenes corrupta

Goniloba corrupta Herrich-Schäffer, 1865, p. 54; Gundlach, 1881, p. 165.
Prenes corrupta: Holland, 1916, p. 509, pl. 31, f. 13; Skinner & Ramsden, 1924, p. 320; Williams, 1931, p. 316.
Prenes nero form *corrupta:* Draudt in Seitz, V, p. 948, pl. 183h (1924).

The broad white band on the under side of the hindwing should serve sufficiently well to characterize this species; the upper side is similar to that of *sylvicola*. Length of f.w., 18 mm.

Dist. In the literature *corrupta* is recorded from many localities in the West Indies and Central America, but Mr. Bell tells me that the typical form is probably limited to Cuba. In the M.C.Z. there is a single specimen from Oriente ("Cuba, Wright"); in the U.S.N.M. there are specimens from Oriente (Santiago de Cuba) and the Isle of Pines.

Genus LXXIV. Asbolis Mabille

Genotype, *Eudamus capucinus* Lucas.

152. Asbolis capucinus

Hesperia cassander: Poey, 1847, p. 245.
Eudamus capucinus Lucas, 1857, p. 625.
Goniloba sandarac Herrich-Schäffer, 1865, p. 54.
Goniloba capucinus: Gundlach, 1881, p. 163.
Asbolis sandarac: Holland, 1916, p. 509, pl. 31, f. 9; Draudt in Seitz, V, p. 944, pl. 183d (1924).
Thymele capucinus: Draudt in Seitz, V, p. 867 (1922).
Asbolis capucinus: Skinner & Ramsden, 1924, p. 320; Williams, 1931, p. 316.

This is a large, very dark species, with no light markings at all on the upper side. The male has a narrow, curved stigma, that extends between veins 2A and Cu_1, hardly differentiated from the rest of the wing in color. The wing bases are covered with some long brown hairs, and perfect specimens show purple reflections on the hindwing and body. On the under side, the base of the forewing is dark, while the apical half and the hindwing are ferrugineous. A light spot is usually indicated between 2A and Cu_2 of the forewing in the male; in the female there is usually an additional light area between Cu_2 and Cu_1. Length of f.w., ♂, 22–23 mm.; ♀, 26–27 mm.

Dist. This species seems to be limited to Cuba; it is not closely related to any other known Antillean form. In the M.C.Z. there are 7 specimens from Oriente, and Sta. Clara (Soledad). The U.S.N.M. specimens are from Oriente and Habana.

Genus LXXV. Perichares Scudder

Genotype, *Papilio coridon* Fabricius.

153. Perichares coridon coridon

Fig. 24, venation

Papilio coridon Fabricius, 1775, p. 533.
Hesperia phocion: Poey, 1847, p. 244.
Eudamus trinitad Lucas, 1857, p. 626.
Goniloba corydon: Herrich-Schäffer, 1865, p. 54; Gundlach, 1881, p. 162.
Perichares corydon: Skinner & Ramsden, 1924, p. 320; Draudt in Seitz, V, p. 995, pl. 192a (1924); Williams, 1931, p. 317.

This species may be distinguished by the yellow, translucent spots of the forewing: a large, curved cell spot, smaller spots between M_3 and Cu_1, and Cu_1 and Cu_2, a tiny spot, often absent, on 2A. There are no subapical spots, and no markings on the upper side of the hindwing. The stigma of the male is similar in position and shape to that of the preceding species. The hindwing, on the under side, is beautifully variegated with brown and violaceous; the under side of the abdomen is conspicuously marked with orange. Length of f.w., ♂, 22–23 mm.; ♀, 26 mm.

Met. Gundlach found the larva on Pará grass; the species is often listed as a sugar-cane pest, and it no doubt feeds on a wide variety of grasses.

Dist. This species has a wide range in tropical America; it is, however, definitely polychoromorphic, and the form *coridon* is probably limited to the Antilles. Cuban specimens show about the same

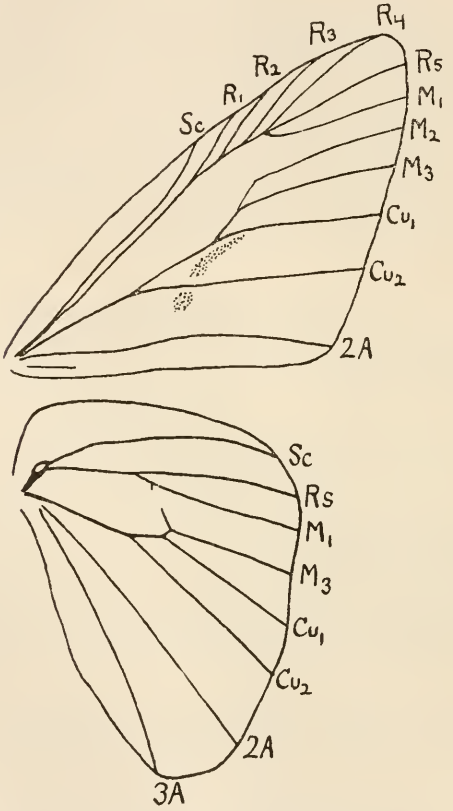

Fig. 24. *Perichares coridon coridon*, venation.

range of variation as those from Jamaica (the type locality). In the M.C.Z. there are 21 specimens from Sta. Clara (Soledad); it is probably common everywhere in Cuba, but generally overlooked because of its crepuscular habits.

Genus LXXVI. Paracarystus Godman

Genotype, *Cobalus hypargyra* Herrich-Schäffer.

154. Paracarystus cubana

Goniloba cubana Herrich-Schäffer, 1865, p. 55; Gundlach, 1881, p. 166; *id.*, 1891, p. 458.
Paracarystus cubana: Skinner & Ramsden, 1924, p. 320; Williams, 1931, p. 318, pl. 27, f. 11.

The wings are brown, with three subapical spots on the forewing, a rather prominent, square cell spot, a similar spot between veins Cu_2 and Cu_1, and a smaller one between Cu_1 and M_3. Expanse, according to Gundlach, 44 mm.; Williams' figure shows the forewing to be about 20 mm. long.

Met. The larva lives on "Platanillo de Cuba" (*Canna*), according to Gundlach.

Dist. The only specimen of this species that I have seen is in the A.N.S.P., from the Poey collection.

Genus LXXVII. Godmania Skinner & Ramsden

Genotype, *Goniloba malitiosa* Herrich-Schäffer.

155. Godmania malitiosa

Goniloba malitiosa Herrich-Schäffer, 1865, p. 54; Gundlach, 1881, p. 165.
Godmania malitiosa: Skinner & Ramsden, 1924, p. 321; Williams, 1931, p. 317, f. 12, pl. 27, f. 10, 12.
Cymaenes malitiosa: Draudt in Seitz, V, p. 983, pl. 189e.

This is a rather fragile little skipper, uniform fuscous above in the female, marked slightly with ochraceous below on the hindwing and the costal margin of the forewing. The male has a peculiar fulvous band on the forewing along the inner margin, bent up toward the apex; it is developed to a variable degree in different specimens. Length of f.w., 14–15 mm.

Dist. This species is probably limited to Cuba; the Central American form passing under the same name seems quite distinct. In the M.C.Z. there are 6 specimens from Oriente and Sta. Clara.

Genus LXXVIII. Thracides Hübner

Genotype, *Papilio phidon* Cramer.

156. Thracides telegonus

Papilio Plebeius Urbanus Telegonus Esper, 1780, p. 33, pl. 56 (cont., 6), f. 3. *Thracides longirostris:* Skinner & Ramsden, 1924, p. 321.

The upper side of the only Cuban specimen that I have seen is a rather uniform dark brown, with several large yellowish hyaline spots on the forewing, including one in the cell, and two similar spots on the disc of the hindwing. The under side is similar, but somewhat lighter, on the forewing; the basal half of the hindwing is very light brown, sharply distinct from the dark outer half. Length of f.w., 20 mm.

The Esper name is the oldest applying to the choromorph complex commonly known as *Thracides longirostris* Sepp. The type locality of *telegonus* is doubtful; Esper mentions "the African coast and the hot lands of Asia." The first reviser of the genus will have to determine a probable locality; the Central American and Cuban form will probably then be described as a new subspecies, since all of the names available seem to apply to South American specimens. There seems to be no point in introducing a new name, however, until sufficient material is available for study.

Dist. There is a single specimen in the U.S.N.M. from Oriente (Baracoa, April); it is very similar to Central American specimens.

DOUBTFUL SPECIES

Papilio palamedes Drury

Poey (1846, p. 234) reports that this species "was captured once some distance from Habana; I have only one very poor specimen in my collection." It is a fairly common insect in southern Florida, and an occasional specimen may well stray across the straits to Cuba. It is a large *Papilio,* resembling *polyxenes* more than any other Cuban species; it has two rows of yellow spots on the outer half of the forewing, the inner row fused to form a band, which does not enter the cell on the hindwing.

Pieris protodice Boisduval & Leconte

Pieris rapae Linnaeus is recorded from Cotorro, Provincia de Habana, in an anonymous note in the Mem. de la Soc. Cubana de Hist. Nat., 8, p. 34 (1934). Mr. S. C. Bruner informs me that his identification is an error, and that the species is really *P. protodice.*

Appias peregrina Röber

This species is discussed under the genus *Appias*. Röber, in the original description, compares it with *Appias ilaire:* "The upper surface is not glossy white, but strongly yellow, particularly on the hindwing, the proximal part of the costal margin of the forewing is more strongly blackened than in *ilaire* and the black border of the forewing is not extended to the inner angle. On the under side the basal half of the cell of the forewing is yellow and the hindwing has a subanal yellowish stripe from the base to the distal margin."

Metamandana dido (Linnaeus)

There is a specimen of this species in the M.C.Z. labelled "Cuba, Wright;" it seems to be identical with Brazilian specimens, however, and I suspect that the locality label is erroneous. The species apparently does occur in Hispaniola, however, and it may yet be found in the Oriente of Cuba. It may be distinguished from any Cuban species except *Metamorpha stelenes* by the translucent green spots of the forewing; from *stelenes* it is easily separated by the elongate, *Colaenis*-like shape of the forewing.

Strymon tollus (Lucas)

Thecla tollus Lucas, 1857, p. 611; Gundlach, 1881, p. 440.

I have not seen this species, and I have been unable to place it from the meagre descriptions of Lucas and Gundlach. Recent authors seem to have overlooked the name. Gundlach states "I have so far found only a single specimen of this species, from the region of Colon (Matanzas). The insect is brown, the base of the forewings and the disc of the hindwings are brilliant blue; the wings are ashy-brown on the under side, the forewings with a dark transverse line through the middle, the hindwings with a white line, bordered on the inside with black, angled toward the anal border. Between the tails there is a small cinnamon spot, and another, black, in the anal angle. Expanse, 27 mm."

Callimormus filata (Plötz)

This species was described from "Cuba," from a specimen supposedly collected by Poey. I know it only from the illustration in the Biologia

Centrali-Americana (pl. 103, f. 32), which looks a deal like *Poanes radians* with a fuscous instead of a fulvous ground color, above and below.

Goniloba singularis Herrich-Schäffer

Herrich-Schäffer, 1865, p. 55; Gundlach, 1881, p. 168; Skinner & Ramsden, 1924, p. 318.

Ramsden, who saw the type of this species, says that it looks very like *Tigasis cornelius*. It has often been placed in the genus *Copaeodes*. Gundlach describes the species thus:

"This is also a species peculiar to the island of Cuba. I collected a single specimen, a male, in the jurisdiction of Guantanamo. I know nothing of its larva or habits.

"The specimen is dark brown, with ferrugineous atoms over the body, the base of the forewings and the entire surface of the hindwings. One sees the characteristic brand rough-black and prominent. Beneath the color is very similar to that above, except for the absence of the brand. Expanse, 40 mm.

"Herrich-Schäffer says that the posterior tibiae do not have a hair pencil, and the mid tibae no row of spines. This indication will serve to place the species generically."

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When a colon is interposed between the species name and the author's name, as *Terias clathea:* Poey, 1846, p. 385, it indicates that

the author did not intend to propose a new name. The citation *Terias palmira* Poey, 1852, p. 198, without the colon, indicates that Poey here proposed the name *palmira* as new. This procedure has seemed necessary in order to distinguish between new names and misdeterminations or misspellings of old names.

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BY LUDLOW GRISCOM

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By Ludlow Griscom

Preface and Acknowledgments

I first became interested in Panama birds in the early winter of 1917, when the late Waldron deWitt Miller and I spent a couple of days in the Canal Zone en route for Nicaragua. During the next few years my chief contact with Panama birds was the final identification and distribution of the great collection from the Rio Tuyra Valley and Mt. Tacarcuna in eastern Darien, made by Richardson, Anthony and Ball for the American Museum of Natural History. By 1924, however, it became apparent that the Republic of Panama was lagging behind other Central American states in thorough modern collecting, and with Dr. Frank M. Chapman's advice and approval, I made plans for the exploration of various neglected parts of the country, work which continued through the next eight years. At that time I compiled a bibliography of Panama ornithology, and prepared a check-list of all the birds recorded from the country. The explorations of the past two decades have increased the list of Panama birds by about 23%.

The time now seems opportune to publish a general summary of these results in the hope that it may prove useful to other workers and stimulate further research. The plan of a check-list with a brief introduction rather than a more extended volume has been decided upon for several reasons. The more extensive type of report is the product of two very different factors (1) it is a critical study of an extensive collection, the importance of which usually transcends all or any other collection made in the political area studied; and (2) the political area studied contains one or more definite faunal areas or "centers of speciation" which merit extended treatment or zoögeographic discussion and analysis. In the present case, there is no one great collection of transcendent importance, and all recent collections have been reported upon already more or less *in extenso*. Secondly, the political boundaries of Panama signally fail to conform to zoögeographic or faunal boundaries. By a curious coincidence the territory of the republic consists wholly of the extreme southern or the extreme northern limits of faunal areas, which have been adequately treated by Carriker for Costa Rica or by Chapman for Colombia. It follows, therefore, that a more elaborate treatment would involve a great amount of repetition.

The field work involved in making these recent collections and their determination afterwards would not have been possible without great

kindness and assistance from many officials and scientific colleagues. In my own expeditions to Panama in 1924 and 1927 I was shown every courtesy by the officials of the Canal Zone, both civil and military. His Excellency, President Porras of Panama was most gracious in permitting the entry of arms and ammunition, and the issuance of collecting permits. Always quietly behind the scenes, Dr. James Zetek would speak a word in my behalf and start the machinery going, which resulted in the privileges already acknowledged above. He is now world famous for his effective hospitality and assistance to naturalists, who are flocking to the Canal Zone.

I am immeasurably indebted to all the officials and curators of the U. S. National Museum, the Bureau of Biological Survey, the American Museum of Natural History, the Carnegie Museum at Pittsburg and the Museum of Comparative Zoölogy for the loan of material, permission to examine Central American birds, and for advice and counsel on technical points. My thanks are warmly extended to Dr. Lowe, Mr. Kinnear and their assistants at the British Museum for the opportunity of examining their Panama treasures, particularly the Arcé types, described by Sclater and Salvin. Henry O. Havemeyer Esq. kindly permitted me to examine his Panama birds collected by Austin Paul Smith, now in his home at Mahwah, New Jersey.

As usual it is my privilege to conclude a preface with some expression of thanks to Dr. Thomas Barbour. He has again afforded me time from other duties for the completion of this paper. He assisted in financing some of the recent exploring work I wished done in eastern Panama, and Henry Wedel would never have gone to the Caribbean Coast of Darien without his assistance and approval. He has probably long since forgotten that he showed me and my assistants much kindness in Panama in 1924, and that the first day we ever spent together was on Taboga Island.

HISTORY OF PANAMA ORNITHOLOGY

To all intents and purposes, Panama ornithology begins with the visit of the French collector Delattre to the Isthmus in 1846. Lafresnaye described six species from Panama in his report on this collection. The Polish botanist Warcewicz secured a few birds in 1849 around David and the lower slopes of the Volcan de Chiriqui, which Gould described. A few years later Dr. J. K. Merritt secured a few birds from Belem on the Caribbean coast, some of which were de-

scribed as new by Lawrence at various times. In the year 1856 a Mr. Bridges sent a small collection from David and Boquete to Sclater, who published a report upon it. In 1862 George N. Lawrence wrote a short article on 39 species of birds sent by F. Hicks to the Smithsonian Institute from David.

In the meantime James McLeannan, track master at Lion Hill on the Panama railroad, had begun his famous collection of the birds of the Isthmus, assisted by John R. Galbraith. In a series of papers on these collections Lawrence recorded 389 species. Salvin, the great English ornithologist, visited the Isthmus in 1863, spending three weeks with McLeannan, who subsequently made a second collection for him of 272 species. Sclater and Salvin's paper on this collection (1864) was of importance, as they were able to compare many of the Panama novelties directly with South American species Lawrence did not have.

Perhaps the next most famous collection ever made in Panama was the work of the Guatemaltecan, Enrique Arcé, for Salvin. Beginning in the early sixties, Arcé established headquarters at Santiago, the capital of Veraguas, and worked northward to the heavy forest at the base of the main Cordillera, and up into the Subtropical Zone on the Pico de Calovevora, back of Sante Fé. The imposing list of localities in Salvin's second paper (P. Z. S., 1870, p. 177) all boil down to minor place names north and northeast of Santiago. The later collections were made at David and the slopes of the Volcan de Chiriqui, up to 6500 feet. In all Arcé secured 432 species of birds, of which many were types or primal records of one kind or another. It might, here, be of interest to complete the story of Arcé's work in Panama, as it is unrecorded information, which I secured in 1924, when in Veraguas. Arcé married, gave up professional collecting and engaged in agricultural enterprise. His collecting was purely intermittent, and he bothered only to pick up the rarities. Small lots of these birds were sold to Festa, when he visited the Isthmus in 1895, and some years later to J. H. Batty, when he was collecting in Chiriqui. Arcé was reported to be still alive at a great age in 1924, when I was in Santiago, and a son was a successful local physician at that time.

The Italian naturalist Festa arrived at the Isthmus in May, 1895, and picked up a few specimens in the Canal Zone and at Porto Bello. From June to September he was in the Rio Tuyra Valley on the Pacific side of eastern Darien, his principal headquarters being near Chepigana, where the Sabana River enters the Tuyra. The many interesting records in this collection have been overlooked by everyone since, ex-

cept Stone. This expedition was the only one ever made in Darien east of the Isthmus, until recent American researches.

Two other foreign collections remain to be mentioned. In 1882 the Swedish traveller, Dr. Carl Bovallius, spent a little time in Panama. Most of it was spent on the Pearl Islands, but he picked up 28 species at Culebra in the Canal Zone, and various minor places near Panama Viejo and Pacora. The mainland birds were not recorded until 1919 by Rendahl, and the Pearl Island collection not until 1920 by the same author. Around 1901–1905 Mr. Henry Watson sent birds to Tring from Boquete, Chiriqui. The novelties and many of the rarer species have been recorded by Hartert, Hellmayr and others in scattered systematic notes.

So far as I know the balance of ornithological collecting in Panama has been done under the auspices of various American institutions. They are briefly summarized below.

A. The collection made by L. L. Jewel in the Canal Zone from 1910–1913, now in the Academy of Natural Sciences at Philadelphia. This was the basis of Dr. Stone's classic paper on the birds of the Canal Zone. I have seen none of the material.

B. The collections made by E. A. Goldman for the Biological Survey in 1910–1911 and 1912; chiefly in the Canal Zone; at Chepo and the Cerro Azul in Darien; at Porto Bello and the Cerro Brujo on the Caribbean side; and the upper Tuyra Valley and the summit of Mt. Pirri. No general report on the birds has ever been published, but the many novelties were described by Nelson, and many of the records appeared in the later volumes of Ridgway's *Birds of North and Middle America*. This expedition bore fruit in Dr. Goldman's volume on the Mammals of Panama (Smiths. Misc. Coll., **69**, no. 5), the introduction of which should be familiar to every one interested in the zoögeography of southern Central America. I have examined all the types in this collection at one time or another.

The remaining collections I am familiar with at first hand, and some I had a share in making myself. They are briefly listed below:

A. Collections made by W. W. Brown for Bangs or Thayer and Bangs, now in the Museum of Comparative Zoölogy.

	skins
1. March, 1900 — Lion Hill, Canal Zone	752
2. Late spring, 1900 — first trip to Pearl Islands	....
3. Oct.–Dec., 1900 — David and Divala, Chiriqui	1182
4. Jan.–Aug., 1901 — Volcan de Chiriqui, including the summit and the Caribbean slope	1189

5. Feb.–April, 1904 — Pearl Islands — both trips..... 867
6. May, 1904 — savannas near Panama City..... 471

B. The collections made by J. H. Batty, now in the American Museum of Natural History.

7. April–June, 1901 — Coiba Island..... ....
8. Boquete and Boqueron, Chiriqui — both..... 672

C. Collections now in the American Museum of Natural History.

9. Anthony, Ball & Richardson in eastern Darien to the summit of Mt. Tacarcuna, 1915..... 2181
10. The collection of Thomas H. Hallinan from the Canal Zone and La Chorrera..... 285
11. Collected by C. M. Breeder, Jr. in eastern Darien, 1924..... 64
12. Exploration of Veraguas by Griscom *et al.* in 1924, continued through 1926 by Rex R. Benson 3100
13. By F. M. Chapman in Canal Zone, 1926..... 132
14. By R. R. Benson at Almirante and Bocas del Toro, 1927..... 800+
15. By Griscom and Crosby, Pearl Islands and Darien, 1927..... 500+

D. Collections now in the Museum of Comparative Zoölogy.

16. Barbour and Brooks in eastern Darien, 1922..... 680
17. Kennard and Wedel, Almirante region, 1926–29..... 1000+
18. R. R. Benson, Cana and Mt. Pirri, Darien, 1928..... 618
19. Wedel, Caribbean Darien, 1929–1931..... 1396

E. Collections now owned by Panama Natural History Society.

20. R. R. Benson, Volcan de Chiriqui..... 1116

F. Collection of Henry O. Havemeyer, Jr.

21. A. P. Smith, Rio Chepo, Darien, Feb.–Apr., 1927..... ....
22. A. P. Smith, Almirante region, Apr.–Aug. 1927 — both trips.. 631

This makes a total of 16,637 specimens of Panama birds examined by me. In addition to this material I have seen all the types described by Nelson from Goldman's collection, I am thoroughly familiar with the McCleannan birds in the Lawrence collection in New York, I have seen the types and all the rare and critical species collected by Arcé in the British Museum, I have examined the type of *Dacnis viguieri* in Paris, and Mrs. M. E. Davison was so kind as to let me see the types of the two remarkable birds collected by her in Chiriqui, before she described them. Of the great list of species and subspecies beyond, I have personal field experience with 701.

The basis for this distributional check-list is, therefore, (1) the records from the reports of the older collections given in the historical summary above, (2) the reports on and study of the twenty-two collections itemized above, and (3) my own field experience in eastern

Chiriqui, various parts of Veraguas, the Canal Zone, the Pearl Islands and parts of Darien.

The bibliography given below aims to list only those papers absolutely essential for a distributional list of Panama birds. It consequently omits all purely systematic works in which Panama birds happen to be mentioned. It also omits all earlier papers, which have been superseded by more complete and more recent papers. Thus the bibliography of the Canal Zone begins with Stone's list of 1918, as that paper compiled all previous records and cites all the previous papers.

Principal Faunal Papers dealing with Panama Birds

1. Panama east of the Canal Zone.

1899. Salvadori and Festa. The travels of Dr. E. Festa in Darien and neighboring regions. Birds. Bull. Mus. Zoöl. Anat. Univ. Turin, (**14**) no. 339.

The first records from eastern Darien. A few records from Veraguas and Chiriqui, based on specimens purchased from Arcé.

1911. Nelson, E. W. Two new subspecies of birds from Panama. Smiths. Misc. Coll., (**56**), no. 22.

1912. Nelson, E. W., *loc. cit.*, (**56**), no. 37.

1912. Nelson, E. W., *loc. cit.*, (**60**), no. 3.

Long list of new genera, species and subspecies from Cana and Mt. Pirri.

1913. Nelson, E. W., *loc. cit.*, (**60**), no. 21.

1911–19. Ridgway, R. Birds of North and Middle America, pts. v-viii.

Contains locality records of Goldman's collecting in Panama for all the groups treated.

1917. Chapman, F. M. Distribution of Bird-Life in Colombia.

Contains numerous references to and critiques of birds from eastern Panama, based on the Anthony, Ball & Richardson collection from the Rio Tuyra and Mt. Tacarcuna. These critiques are sometimes the first record of a species from Panama.

1922. Bangs and Barbour. Birds from Darien. Bull. Mus. Comp. Zoöl., (**65**), no. 6, pp. 191–229.

Many new subspecies and other birds new to Panama.

1926. Chapman, F. M. The Distribution of Bird-Life in Ecuador.

Greatly increased number of references to the birds of eastern Darien in the American Museum collections. In many cases "eastern Panama" given in the paragraph on range is the first record of genus or species from the Republic.

1927. Griscom, Ludlow. An ornithological reconnaissance in eastern Panama in 1927. Amer. Mus. Novit., no. 282.

New subspecies described and numerous additions to the Panama avifauna.

1929. Griscom, Ludlow. A collection of birds from Darien. Bull. Mus. Comp. Zoöl., (**69**), no. 8, pp. 149–190.

Notes on Benson's work at Cana and the lower slopes of Mt. Pirri. New subspecies described and numerous additions to the Panama avifauna.

1932. Griscom, Ludlow. The ornithology of the Caribbean coast of extreme eastern Panama. Bull. Mus. Comp. Zoöl., (**72**), no. 9, pp. 303–372.

1933. Griscom, Ludlow. Notes on the Havemeyer Collection of Central American birds; Rio Chepo, Darien. Auk, 1933, pp. 301–308.

One or two novelties to the ornis of Panama, and notes on certain very rare and little known species.

2. Canal Zone and immediately adjacent areas of Panama.

1906. Thayer and Bangs. Vertebrata from the Savanna of Panama; Aves. Bull. Mus. Comp. Zoöl., (**46**), no. 12, pp. 213–224.

1918. Stone, Witmer. Birds of the Panama Canal Zone. Proc. Acad. Nat. Sci., 1918, pp. 239–280.

A complete report, summarizing all records and all previous papers, listing 432 species.

1924. Hallinan, Thomas. Notes on some Panama Canal Birds, etc. Auk, 1924, pp. 304–326.

One or two novelties to the Panama ornis. The territory includes La Chorrera in Panama just west of the Canal Zone.

3. Pearl Islands.

1905. Thayer & Bangs. Birds of the Pearl Islands, Bay of Panama. Bull. Mus. Comp. Zoöl., (**46**), no. 8, pp. 137–160.

1920. Rendahl, Hialmar. A list of the birds of the Pearl Islands, Bay of Panama. Arkiv. för Zoöl., (**13**), no. 4, 56 pp.

Based on the collection of Bovallius in 1882, but including the records of Thayer and Bangs. Adds 5 species to the Pearl Island list.

4. Western Panama, except extreme western part.

1867. Salvin, Osbert. On some collections of birds from Veragua. P. Z. S., 1867, pp. 129–161.

The famous report on Arcé's first collection from Santa Fé and Santiago, Veraguas, and Tolé (now in eastern Chiriqui). This paper, however, uses "Veragua" in the old general sense, and consequently includes all published records from Chiriqui.

1870. Salvin, Osbert. On some collections of birds from Veragua, Part II. P. Z. S., 1870, pp. 175–219.

Records 216 additional species from the mountains north and northeast of Santiago, Veraguas.

1924. Griscom, Ludlow. Description of new birds from Panama and Costa Rica. Amer. Mus. Novit., no. 141.

Novelties resulting from collections made in the high mountains in eastern Chiriqui, back of Remedios, and the coastal forests of Veraguas.

1927. Griscom, Ludlow. Undescribed or little known birds from Panama. Amer. Mus. Novit., no. 280.

Brief report on the novelties and additions to the Panama avifauna secured by Rex R. Benson in a series of expeditions, as follows: (1) Head of Montijo Bay, Veraguas, (2) mountains back of Santa Fé, Veraguas, (3) interior of Cape Mala peninsula, Los Santos (4) arid plains near Agua Dulce, Coclé, (5) high mountains back of Chitra. Veraguas (6) Rio Calovevora, Caribbean lowlands of Veraguas.

5. Almirante Region, now in Bocas del Toro.

1928. Griscom, Ludlow. New birds from Mexico and Panama. Amer. Mus. Novit., no. 293.

Chiefly a report on Benson's collection from Almirante and Bocas del Toro. In addition to several novelties, 23 species added to the avifauna of Panama.

1931. Peters, James L. Additional notes on the birds of the Almirante Bay region of Panama. Bull. Mus. Comp. Zoöl., (**71**), no. 5, pp. 293–345.

Complete list of 315 species found by Kennard, Benson & Wedel.

1933. Griscom, Ludlow. Notes on Central American birds in the Havemeyer Collection. Auk, 1933, pp. 300–301.

Records ten species additional to Peter's list, collected by A. P. Smith.

6. The department of Chiriqui.

1901. Bangs, Outram. On a collection of birds made by W. W. Brown, Jr. at David & Divala, Chiriqui. Auk, 1901, pp. 356–370.

A splendid collection containing new forms and many additions to the Panama avifauna.

1902. Bangs, Outram. On a second collection of birds made in Chiriqui by W. W. Brown, Jr. Proc. New England Zoöl. Club, (3), pp. 15–70.

A magnificent collection, chiefly from the Volcan de Chiriqui. Brown is the only man who ever secured birds above 8000 feet to the summit of the volcano,

These two articles combined give a practically complete list of the birds of Chiriqui. Less than eight others are recorded in minor systematic papers.

GENERAL PHYSIOGRAPHY AND CLIMATE

Compared to the highly complex and mountainous countries both north and south of Panama, this republic is very simple to describe. In Darien the western Andes of Colombia are continued northward as two main spurs, separated by the depression of the Atrato River valley. The core of the continent is mountainous, with steadily decreasing altitudes to the Canal Zone. Altitudes of 3000 feet are reached quite abruptly a short distance east of the Canal Zone. There would appear to be very little increase of altitude (and no real breaks) until extreme eastern Darien, where the mountains rise to 5500 feet, or a little more, just west of the Colombian border. The spur of Mt. Pirri shoots southward towards the coast and would appear to be about 5500 feet high also. The greater part of the summit of this long central axial ridge has never even been approached by a white man. The other two outstanding physiographic features of Darien are the relatively narrow and very steep coastal plain on the Caribbean side, and the relatively broad coastal plain on the Pacific side, with several really long, though shallow rivers, like the Tuyra, the Chucunaque, the Bayano and the Chiman.

West of the world famous Isthmus of Panama, these general physiographic features are duplicated with most unusual exactness. The central core of the continent is again a long mountain ridge, gradually rising west of the Isthmus, and attaining an altitude of about 3000 feet back of Coclé. It rises to 5500–6000 feet back of Santa Fé, Veraguas, and is remarkable for the uniformity of outline and the lack of prominent peaks. Two or three minor peaks reach 7000 feet back of Remedios in eastern Chiriqui (the so-called Cerro Flores); there is apparently a marked decrease in altitude in the main range somewhere in central Chiriqui, and at the extreme western end of the republic, the Volcan de Chiriqui rises quite abruptly to 11,500 feet. As in Darien the Caribbean coastal plain is often quite narrow and steep; it is destroyed entirely by spurs from the mountains which reach the coast east of Almirante Lagoon, where, however, there is locally considerable alluvial plain. There are chains of coral reefs, islets and cays at the mouth of the Lagoon, containing some birds of great interest. The coastal plain on the Pacific side is relatively broader and less steep than much of the Caribbean, but does not compare with Darien in this respect, and there are no rivers of comparable size. The very broad Cape Mala Peninsula has a minor central mountain core all its own. The highly irregular coast gives every appearance

of being a drowned one, rocks, islets and some islands of fair size, like Coiba, being exceedingly numerous at very short distances off shore, indicating either submergence or an axial tilting at some past period.

Climatic features are equally simple to describe. Except for the central mountain ranges above 3000 feet, the whole country is in the Tropical Zone. The whole Caribbean slope is very humid without any marked dry season, and the rainfall averages 180 inches annually, in exceptional seasons less, and often considerably more in special sections where the mountains come closer to the shore. The depression of the Canal Zone perhaps contributes to a factor otherwise unknown in Central America. The "rain shadow" crosses the continent in a sharp northeast to southwest diagonal in Darien, resulting in a very humid climate on the Pacific slope of the eastern half of Darien, which presumably merges into the even more humid climate on the Pacific coast of Colombia.

West of this "rain shadow" on the Pacific slope, there is a marked dry season of several months duration, and the annual rainfall averages only about half that on the Caribbean slope. These climatic features are exactly similar to the balance of the Pacific coast of Central America and for the same reason, namely that the unbroken central mountain ranges block or absorb the precipitation from the moisture laden northeast trade winds blowing in over the Caribbean.

Ecological factors follow closely upon the climatic. The entire country in the humid tropical zone is covered with a dense tropical rain forest, which in the wetter areas is almost impenetrable without trail cutting. It has a perfectly enormous bird fauna, which in eastern Darien is almost inexhaustible, to quote Goldman's happy phrase. Crosby and I collected over 200 species in less than two weeks around Cape Garachine, and over 400 species are recorded from the Tuyra valley. Compared to eastern Darien the avifauna of the Caribbean rain forest of western Panama is relatively depauperate, but 300 species have been found around Almirante.

The radically different climate on most of the Pacific or southern slope of Panama also causes very different ecological features, resulting in several distinct bird faunas. Most of western Panama is typically Central American in that the coastal strip was (formerly at least) covered with a very fine forest. While it contains a great variety of trees of impressive to gigantic size and girth, it is an open or "gallery" forest, with little or no undergrowth to impede travel on foot in any desired direction. This forest has been destroyed in much of Chiriqui, but survives in primeval magnificence on the uninhabited coast of

Veraguas and the Cape Mala Peninsula. This forest contains a far less variety of birds than the humid tropical forest, but in Costa Rica and western Panama has an interesting assemblage of endemic species and subspecies, which represent characteristic and widely ranging humid Caribbean forest species. The eastern limit of this forest is on the east side of the Cape Mala Peninsula.

North of this forest belt, or inland, there is a more or less continuous belt of savanna and scrub country, the exact features of which are soil rather than climatic problems. In much of Chiriqui, these savannas are rich affairs, affording excellent natural pastures for cattle, there is no scrub forest at all, and the rolling savannas are bisected by streams with wooded borders. Between Tole and Santiago in Veraguas lies a region of inconceivably dreary and barren aspect, caused by an extensive outcrop of blackish, stony volcanic rock. Not even a bush grows in this benighted looking country, and almost the only birds are meadowlarks and Fork-tailed Flycatchers. East of Santiago, through Coclé to Agua Dulce, is a sandy or gravelly tract covered with a thorny scrub, and the country is surprisingly like Texas chaparral or the scrub country in so much of the Central American Arid Tropical Zone far to the northward. A few great specialties occur here. Still further east we return to the usual savanna country, varied with a low type of scrub forest. These patches of scrubby woodland are largely leafless in the dry season, and look for all the world like a third growth New England woodlot in October. Savannas extend as far east as Chepo in Darien, and one kind of dry woodland or another occurs locally on the outer coast of Darien, as at Cape Garachine, and up the Tuyra and other large river valleys. The very great majority of the birds characteristic of this type of country are unknown, however, east of Chepo.

Returning to the western half of Panama the savanna country extends inland to the base of the mountains and very locally up their slopes. As a general rule, however, heavy forest again reappears at the base of the mountains and extending up their slopes, gradually passes into the Subtropical Zone forest at the usual altitudes. The final detail to mention is a narrow tongue of humid rain forest which extends up from the Canal Zone at the foot of the mountains as far west as Santa Fé in Veraguas. A very few Caribbean lowland species occur in this strip of forest, one of the few instances of the sort on the Pacific slope of Central America.

LIFE-ZONES OF PANAMA AND THEIR BIRD-LIFE

As stated earlier in the introduction, the republic of Panama is a political but not a zoögeographic entity. Faunally Panama is as sharply divided into two halves by the Isthmus, as is any continuous land area in the New World with an equal continuity of climatic and ecological divisions. Western Panama is the southern end of the Central American Subregion, and its montane avifauna is practically identical with that of the Costa Rica highlands. Eastern Panama or Darien is the northern apex of the humid rain forest Colombian-Pacific and Magdalena Faunas of Colombia, and its montane avifauna is a continuation of that of the western Andes of Colombia, though considerable subspecific and even specific segregation has taken place. The lowland depression of the Isthmus is a transition area between these two Subregions, and the bird-life of the Isthmus itself is a mixture, which can be easily explained on topographic and ecological grounds. On the Caribbean coast the approach of the mountains to the coast just east of Almirante Bay apparently acts as a final barrier southward and eastward to the characteristic species peculiar to the Central American Humid Tropical Zone. The humid northern half of the Canal Zone consequently possesses a decided element of South American birds, but scarcely one bird that is purely Central American. This situation is reversed on the Pacific or dry side of the Canal Zone. Here the savannas and scrub forest of western Panama extend right across the Isthmus at least as far east as Chepo, and consequently birds characteristic of the Central American Subregion come much nearer to South America than they do on the Caribbean slope. In fact the characteristic avifauna of the Colombian-Pacific Fauna is not reached on the Pacific slope of eastern Panama until well east of the line where the "rain shadow" crosses the continent.

A. Western Panama

I. Temperate Zone.

The Temperate zone in western Panama is well developed on the Volcan de Chiriqui above 7000 feet and there is a marked tinge of it on the highest peaks further east, such as the Cerro Flores back of Remedios in Chiriqui, the Pico Calovevora back of Santa Fé, Veraguas, and the summit of the ridge back of Chitra. The avifauna is the characteristic and well known one of the Costa Rican highlands, re-

markable for at least one peculiar family, numerous endemic genera and the very great majority of the species peculiar to it also. On the Volcan de Chiriqui minor subspecific variation occurs in a relatively few cases, but further east some specific and considerable racial segregation takes place.

List of Characteristic Temperate Zone Birds.

Chamaepetes unicolor
Odontophorus guttatus
Glaucidium jardini
Caprimulgus saturatus
Panterpe insignis
Eugenes spectabilis
Oreopyra hemileuca and *cinereicauda*
Selasphorus torridus
Pharomacrus mocinno costaricensis
Scytalopus argentifrons and *panamensis*
Cranioleuca erythrops rufigenis
Margarornis rubiginosa rubiginosa and *boultoni*
Premnoplex brunnescens brunneicauda and *distinctus*
Pseudocolaptes boissonneautii lawrencii and *panamensis*
Myiochanes lugubris
Empidonax atriceps
Cyanolyca argentigula blandita (the race, Panama only)
Thryorchilus browni browni (the race, Panama only)
Turdus nigrescens
Catharus gracilirostris accentor (the race, Panama only)
Zeledonia coronata
Ptilogonys caudatus
Vireo carmioli
Diglossa plumbea plumbea and *veraguensis*
Myioborus torquatus
Basileuterus tristriatus subsp.
Basileuterus melanogenys eximius and *B. bensoni*
Chlorospingus pileatus pileatus and *diversus*
Junco vulcani
Pselliophorus tibialis and *luteoviridis*
Pezopetes capitalis

An inspection of this list shows that in only three cases is the bird of the Volcan de Chiriqui racially different from the Costa Rican form. In Veraguas, however, three birds are specifically distinct, and there are five cases where racial segregation has taken place.

II. Subtropical Zone.

So far as known the Subtropical Zone is continuous in western Panama from the Costa Rican border to the disappearance of the central mountain chain in the depression of the Isthmus. This Zone consequently occupies a narrow belt on both the Caribbean and Pacific slopes, which begins at about 3000 feet on the Caribbean side and 3500 feet on the Pacific. The central mountain range is mostly so low that the Zone goes right across the summit, but on the Volcan de Chiriqui, the Pacific and Caribbean slope belts are separated by the extensive area of the Temperate Zone above them. We find here a continuation of conditions in Costa Rica, so that certain species of birds are confined to one element or another of the Zone. Examples follow:

Leucopternis princeps — Caribbean slope only
Oreopeleia lawrencei — Caribbean slope only
Oreopeleia chiriquensis — Pacific slope only
Bolborhynchus lineola — Caribbean slope only
Eupherusa egregia — Pacific slope only
Callipharus nigriventris — Caribbean slope only
Elvira chionura — Pacific slope only
Catharus mexicanus — Caribbean slope only
Catharus griseiceps — Pacific slope only
Tangara lavinia dalmasi — Caribbean slope only
Tangara gyroloides bangsi — Pacific slope only
Chrysothlypis chrysomelas — Caribbean slope only

The features of the bird-life of the Subtropical Zone have been so clearly brought out by Chapman (Birds of Colombia, pp. 151–159), and by me (Birds of Guatemala, pp. 54–64) that there is no point in repetition here. Chapman in particular (*loc. cit.*, pp. 158–159) gives some interesting comparative tables, in which the Costa Rica – west Panama representatives of Colombian species are listed in the right hand column. I might only add that changes of opinion, additional material, etc., have served greatly to reduce the number of cases, where the representative birds are specifically distinct. Those really worthy of emphasis here are the ones peculiar to Central America or endemic in the Costa Rica-Chiriqui highlands, which do not obviously represent some Colombian species. These are:

Odontophorus leucolaemus — endemic
Pyrrhura hoffmanni — endemic
Otus nudipes — endemic
Eupherusa egregia — endemic

Callipharus nigriventris — genus endemic
Elvira chionura — endemic
Oreopyra castaneoventris — endemic, Chiriqui only
Oreopyra calolaema — endemic
Nesophlox bryantae — endemic
Selasphorus ardens — west Panama only
Selasphorus scintilla
Dryobates villosus
Balanosphyra formicivora
Oxyruncus cristatus — reappearing in Guiana and S. E. Brazil
Procnias tricarunculata
Empidonax flavescens
Turdus plebejus
Catharus mexicanus
Catharus frantzii
Phainoptila melanoxantha — endemic genus
Vermivora gutturalis

III. Tropical Zone.

In addition to the usual long list of widely ranging Neotropical types, the bird life of the Tropical Zone in western Panama contains several elements worthy of special comment. The first and most striking of these is the list of endemic species, characteristic of the Central American Humid Tropical Fauna, which reach their southern (or eastern) limits in western Panama in or about the Almirante Region. While some of these birds range north to Guatemala or southeastern Mexico, a large proportion are endemic in eastern Nicaragua and Costa Rica. There are an even larger number of subspecies, which will be discussed in another connection.

Odontophorus melanotis coloratus (the race, Panama only)
Aratinga finschi (also on Pacific slope)
Aratinga astec
Pionus senilis
Trogon bairdi
Piculus simplex (also on Pacific slope)
Celeus castaneus
Phlœoceastes guatimalensis
Oncostoma cinereigulare (also on Pacific slope)
Empidonax albigularis
Manacus cerritus (endemic species; *candei* in Central America)
Carpodectes nitidus
Thryothorus zeledoni

Thryothorus thoracicus
Thryothorus atrogularis
Pheucticus tibialis (also on Pacific slope)
Sporophila corvina
Caryothraustes poliogaster subsp.
Tanagra gouldi praetermissa (the race, Panama only)
Ramphocelus passerinii
Phlogothraupis sanguinolenta
Tachyphonus axillaris
Gymnostinops montezuma (extending to Canal Zone)
Icterus prosthemelas
Psilorhinus mexicanus captus (the race, Panama only)

The second, and perhaps the most interesting, element in the Tropical Zone avifauna of western Panama is the marked endemic group of species and subspecies that occur in the coastal gallery forest on the Pacific slope of southwestern Costa Rica and western Panama. These birds can be divided into three groups, (1) those which represent humid rain forest Caribbean slope species (2) those which represent South American birds only and do not occur elsewhere in Central America (3) particularly plastic and more widely ranging birds which break up into numerous local races. The third group will be discussed beyond. A list of the first two groups follow:

Leptotila rufinucha
Odontophorus guianensis castigatus — Otherwise South American[1]
Oreopeleia costaricensis — represents *O. lawrencei*
Aratinga ocularis — nearest ally South American
Amazona ochrocephala panamensis — otherwise South American
Otus choliba luctisonus — otherwise South American
Chaetura fumosa — represents *C. cinereiventris*
Phoethornis guy coruscus — otherwise South American
Polyerata decora — represents *P. amabilis*
Lepidopyga caeruleogularis — otherwise South American
Saucerottea edward — nearest ally South American
Damophila juliae panamensis — otherwise South American
Chlorostilbon assimilis — nearest ally South American
Anthracothorax veraguensis — nearest ally West Indian
Trogon bairdi — represents the South American *T. strigilatus.*
Pteroglossus frantzii — represents *P. torquatus*
Centurus chrysauchen — represents *C. pucherani*
Veniliornis kirkii neglectus — otherwise South American
Thamnophilus bridgesi — nearest ally South American

[1]This term including eastern Panama.

Terenura callinota — otherwise South American
Cercomacra nigricans — otherwise South American
Philydor fuscipennis — otherwise South American
Xenops rutilus septentrionalis — otherwise South American
Sclerurus albigularis canigularis — otherwise South American
Pipra pipra anthracina — otherwise South American
Chiroxiphia lanceolata — otherwise South American
Manacus aurantiacus — represents *M. candei* and *cerritus*
Cotinga ridgwayi — represents *C. amabilis.*
Carpodectes antoniae — represents *C. nitidus.*
Myiodynastes maculatus nobilis — otherwise South American
Myiarchus ferox panamensis — otherwise South American
Tolmomyias sulphurescens flavo-olivaceus — otherwise South American
Atalotriccus pilaris wilcoxi — otherwise South American
Elaenia chiriquensis — otherwise South American
Thryothorus semibadius — nearest ally South American
Thryothorus fasciato-ventris melanogaster — otherwise South American
Pheugopedius rutilus hyperythrus — otherwise South American
Ostinops decumanus — otherwise South American
Tanagra crassirostris — otherwise South American
Ramphocelus costaricensis — represents *R. passerinii*
Ramphocelus dimidiatus albirostris — otherwise South American
Tachyphonus nitidissimus — represents *T. delatrii*
Sporophila schistacea crissalis — otherwise South American
Sporophila gutturalis — otherwise South American
Saltator striatipictus subsp. — otherwise South American

A study of this list shows graphically how preponderating is the South American element, and how few are the species of the Caribbean rain forest that are represented by specifically separable forms. There are a greater number of cases where subspecific differentiation occurs, but in all these cases the same species occurs in eastern Panama and Colombia. There is, however, an obvious explanation for this state of affairs, primarily an ecological one. Field experience shows that the coastal forests of the Pacific coast are quite different from the dense humid jungles of the Caribbean coast, and few are the birds that find a congenial habitat in *both* types. The long list of birds requiring humid jungles range down the Caribbean coast of Central America, cross Panama, where the rain shadow crosses the continent, and range down the Pacific coast of Colombia to west Ecuador. The long list of South American derivatives in the gallery forests of the Pacific coast of western Panama are not characteristic of the Colombian-Pacific or Cauca-Magdalena Faunas, but reappear in the arid upper

Dagua Basin, in the drier parts of the Magdalena valley or on the arid north coast of Colombia. This relationship is far more clearly brought out by inspecting the list of birds characteristic of the savanna belt.

The factor causing so much specific or racial endemism is the usual one of isolation. The savannas and scrub forest of western Panama are separated from similar country in Colombia by a great belt of rain forest, containing a different avifauna. The coastal gallery forest is still further isolated by being entirely surrounded by savannas. Northward in Costa Rica, these savannas pass gradually into the arid tropical scrub of the Central American Pacific coastal plain, where a totally different avifauna of more northern origin reigns supreme.

I give below a list of the birds characteristic of the savanna and scrub forest belt north of the coastal gallery forests in western Panama. Those marked with an asterisk are primarily Middle rather than South American. The others are all South American species. None are known from rain forest areas.

1. Characteristic savanna or scrub forest birds.

Asturina nitida costaricensis
Milvago chimachima cordatus
Colinus leucotis panamensis
Centurus rubricapillus wagleri
Synallaxis albescens hypoleucus
Myiophobus fasciatus furfurosus
Sublegatus modestus glaber
Tyrannulus elatus panamensis
Heleodytes albobrunneus
**Rhodinocichla rosea eximia*
Anthus lutescens parvus
Hylophilus viridiflavus — endemic species
**Tangavius aeneus involucratus*
Leistes militaris
**Tanagra gracilis*
Emberizoides sphenurus subsp.

2. Known only from the arid plains near Agua Dulce.

Falco fusco-caerulescens
**Melopelia asiatica australis*
Phaeomyias murina incompta

3. Known only from the Pearl Islands.

Phaethornis anthophila hyalina
Neorhopias grisea alticincta
Coereba cerinoclunis — endemic species

B. Eastern Panama

I. Temperate Zone.

Not definitely known to exist in eastern Panama.

II. Subtropical Zone.

Still only partly explored in eastern Panama, and excessively difficult of access. Many discoveries of interest undoubtedly await the explorer so fortunate as to reach a previously unvisited section or able to remain at this altitude sufficiently long really to exhaust the fauna. The birds belong to two main groups, (1) those of wide distribution, represented both in Central America and the Andes of Colombia, and (2) those which are purely South American in the sense that they are not represented in Central America. A very small third group is Central American without any obvious Andean ally.

1. Species represented both in Central and South America.

Columba subvinacea berlepschi
Pharomacrus auriceps
Streptoprocne zonaris albicincta
Eutoxeres aquila munda — endemic subspecies
Heliodoxa jacula jacula
Trogon collaris extimus — endemic subspecies
Eubucco bourcieri anomalus — endemic subspecies
Veniliornis oleaginus subsp.
Scytalopus panamensis — endemic species, representing *argentifrons* of Costa Rica and *micropterus* of the Andes.
Grallaricula flavirostris brevis — endemic subspecies
Grallaria guatimalensis chocoensis
Cranioleuca erythrops griseigularis
Margarornis bellulus — endemic species, representing *rubiginosa* of Central America and *stellata* of the Colombian Andes.
Premnoplex brunnescens albescens — endemic subspecies
Xenoctistes subalaris tacarcunae — endemic subspecies
Xenops rutilus heterurus
Mitrephanes berlepschi eminulus — endemic subspecies

Lophotriccus pileatus squamaecrista
Leptopogon superciliaris troglodytes — endemic subspecies
Troglodytes ochraceus festivus — endemic subspecies
Henicorhina leucophrys leucophrys
Myadestes coloratus — endemic species, representing *melanops* of Central America and *ralloides* of the Andes
Turdus obsoletus subsp.
Catharus fuscater fuscater
Myioborus verticalis pallidiventris
Basileuterus tacarcunae — endemic species, representing *tristriatus* of Central America and the Andes.
Tangara guttata eusticta
Tangara gyroloides gyroloides
Buarremon brunneinuchus

2. Species not represented in Central America.

Oreopeleia goldmani — no really close relative
Urochroma dilectissima
Androdon aequatorialis
Vestipedes aureliae caucensis
Goethalsia bella — endemic genus
Lochmias nematura sororia
Pseudotriccus pelzelni berlepschi
Chlorospingus tacarcunae — no really close relative
Buarremon atricapillus tacarcunae

3. Species represented in Central America only.

Otus nudipes
Aulacorhynchus caeruleogularis cognatus — endemic subspecies
Oxyruncus cristatus brooksi — the species reappearing in Guiana and Brazil
Basileuterus ignotus — representing *B. melanogenys.*
Tangara fucosa — represents *T. dowii*
Chrysothlypis chrysomelas ocularis — endemic subspecies
Chlorospingus inornatus — representing *C. hypophaeus.*

The allocation of various birds to one or another of these groups is often a matter of taxonomic opinion. Thus to select examples at random, *Scytalopus panamensis* might easily be regarded as conspecific with the Central American *argentifrons* and the Andean *micropterus.* For many decades no one would have questioned the specific distinctness of *Myadestes melanops* of Costa Rica and *ralloides* of the Andes. *M. coloratus* is just half way between the two, and Dr. Hellmayr has

just suggested reducing them all to a group of subspecies. The case of the little flycatcher *Mitrephanes* is slightly different again. No one would question the fact that the Central American *phaeocercus-aurantiiventris* group closely represents the Andean *berlepschi-olivaceus* group, or that we have a gradual progression from an olive green and yellowish bird in the far south to a brown and cinnamon bird in the far north. The most marked change occurs on either side of the Panama fault. This fact can be recognized in nomenclature by keeping the birds on each side of it specifically distinct, or it can be ignored, as Dr. Hellmayr would do. *Eminulus* of eastern Panama is clearly nearer *berlepschi* of Colombia than *aurantiiventris* of western Panama, and this is the usual rule, and just what common sense would expect. An exceptional and diametrically opposite case is the Green Toucanet. The blue-throated *Aulacorhynchus caeruleogularis* of Costa Rica presumably represents the Andean *albivitta*, in the sense that nearly all green Toucanets represent each other. *Albivitta* has a white throat, while *albivitta griseigularis* of the northern end of the western Andes, geographically nearest to *A. caeruleogularis cognatus*, has a gray throat. It could, of course, be argued that a gray throated bird was a connecting link between a white-throated and a blue throated bird. Those who wish to maintain this view would remove the Green Toucanet of eastern Panama from Group 3 and transfer it to Group 1. I prefer, however, to maintain two species of Toucans, and *cognatus* with a blue throat is obviously nearer the Central American than the Andean bird. Such a case, however, cannot be as satisfactory as the *Chrysothlypis* in the same Group 3, where the genus is unknown in the Andes.

I refrain from any statistical analysis of the strength of the various elements in the Subtropical avifauna of eastern Panama, as I am convinced that thorough exploration might easily double the present list, and an analysis today would be rashly premature.

III. The Tropical Zone.

In discussing the bird-life of this Zone in eastern Panama, I am here concerned solely with that part of the Republic the avifauna of which is South American. I have already shown that the savanna and scrub forest country of western Panama crosses the Isthmus on the Pacific side, bringing with it a strong element of Central American birds. Faunally speaking the South American part of eastern Panama is that section of the Republic east of the Isthmus, which lies east of the "rain-shadow."

There are two main ecological divisions in this territory. Perhaps eighty percent of it is covered with dense rain forest, as usual inhabited by a positively colossal variety of birds. Here and there, however, there are sections of a different type of woodland, which Goldman lumped in his Arid Tropical Zone. It is true that this forest is far more open, interspersed with scrubby thickets, and that many of the trees lose their leaves. This type of woodland is found along the outer coast and along some of the broader river valleys like the Tuyra. The outstanding feature of this open woodland is the gigantic and picturesque cuipo tree (*Cavanillesia* sp.). While it must be admitted that in certain ecological features, this forest resembles the open gallery forests of western Panama, there are fundamental differences, not only in aspect and in the tree flora, but also in the factors producing it. One is climatic. In Central America it has always been assumed that the more open forests of the Pacific slope were the result of the greatly decreased precipitation and the prolonged dry season. This cannot possibly be the case in eastern Darien, where one can pass in the course of a few hundred yards from the cuipo forest into the gigantic green wall of the rain forest. I suspect that some soil factor must be the cause, just as that is the explanation in so much of Pacific Central America as to the local presence of fine gallery forest or thorny chapparal. However this may be, the cuipo forest is inhabited by a totally different assemblage of birds from the rain forest jungle. They are two different worlds, and the bird-life of the cuipo forest is a different world entirely from the arid tropical forests of western Panama; in fact the birds belong to different grand divisions of the Neotropical Region. Lists of the more characteristic South American birds follow.

1. Characteristic South American birds of the rain forest areas.

Pilherodius pileatus — extends to Canal Zone
Butorides striatus subsp. — extends to Canal Zone
Morphnus taeniatus
Coccycua rutila panamensis — extends to Canal Zone
Crotophaga major
Ara ararauna — extends to Canal Zone
Ara chloroptera — extends to Canal Zone
Ara severa
Pyrilia pyrilia
Nyctibius grandis — extends to Canal Zone
Chaetura chapmani — extends to Canal Zone
Chaetura spinicauda spinicauda

Goldmania violiceps — endemic genus
Trogon strigilatus chionurus — extends to Almirante
Momotus subrufescens reconditus — endemic
Brachygalba salmoni
Notharchus pectoralis — extends to Canal Zone
Nystalus radiatus — extends to Canal Zone
Nonnula frontalis
Capito maculicoronatus subsp. — extends to Canal Zone
Ramphastos ambiguus abbreviatus — extends to Canal Zone
Phloeoceastes splendens — extends to Almirante
Myrmotherula brachyura ignota — extends to Canal Zone
Myrmotherula surinamensis pacifica — extends to Veraguas
Myrmeciza maculifer cassini
Xenornis setifrons — endemic genus
Xenerpestes minlosi
Automolus nigricauda saturatus
Pipra erythrocephala
Chloropipo holochlora suffusa
Manacus vitellinus subsp. — extends to Veraguas
Sapayoa aenigma
Cotinga nattereri — to Canal Zone
Sirystes sibilator albogriseus — extends to Canal Zone
Myiozetetes cayannensis harterti — extends to Canal Zone
Pitangus lictor panamensis — extends to Canal Zone
Aphanotriccus audax — extends to Rio Chepo
Cnipodectes subbrunneus — extends to Canal Zone
Oncostoma olivaceum — extends to Canal Zone
Elainea gaimardii macilvaini — extends to Canal Zone
Neochelidon tibialis — extends to Canal Zone
Thryothorus nigricapillus subsp.
Thryothorus leucopogon subsp.
Thryothorus leucotis subsp. — extends to Canal Zone
Thryothorus spadix subsp.
Turdus daguae
Polioptila schistaceigula
Smaragdolanius eximius mutabilis
Hylophilus aurantiifrons aurantiifrons — extends to Canal Zone
Dacnis viguieri
Gymnostinops guatimozinus
Cacicus vitellinus — extends to Canal Zone
Tersina viridis occidentalis
Tanagra xanthogastra chocoensis
Tanagra fulvicrissa fulvicrissa — west to Veraguas
Tangara palmeri
Tangara inornata languens — extends to Canal Zone

Ramphocelus icteronotus — west to Almirante
Chlorothraupis olivaceus
Hemithraupis flavicollis ornatus
Caryothraustes canadensis simulans

With the exception of the two endemic genera and *Dacnis viguieri* every species in this list is a characteristic bird of either the Colombian-Pacific Fauna, the Cauca-Magdalena Fauna or both. Many, like the Macaws and *Tersina*, are of wide South American distribution. We are dealing with a really little explored region, and I venture the prediction that the two supposed endemic genera, *Goldmania* and *Xenornis* and the *Dacnis* will eventually be found in one part of Colombia or another in the area occupied by the two Faunas mentioned above. With these two exceptions, endemism is at a minimum in eastern Panama, a mere handful of subspecies of particularly plastic types. This is just what is to be expected, as the great factor of endemism, isolation, is absent. The climate and rain forest habitat are uniform and continuous.

It is this very continuity of climate and habitat that raises a problem of fascinating biological interest. What are the factors that limit the northward or westward distribution of the various birds? Let us consider the facts statistically. In the Colombian-Pacific Fauna of western Colombia, there are about 100 autochthonous species, and in the humid section of the Cauca-Magdalena Fauna there are another hundred characteristic species, though the autochthonous forms are far fewer. Of these two groups only 61 species reach eastern Darien. Of these 61, twenty-five reach the Canal Zone, and only 6 extend west of it, actually interdigitating with the Central American Humid Tropical Fauna, which is, incidentally, depauperate, compared to the Colombian-Pacific Fauna, in the number of autochthonous species. The point should most certainly be made that further exploration in the humid jungles of eastern Darien might indeed greatly increase the list of 61 species at present known. But this same point most certainly cannot be made as regards the 25 species reaching the Canal Zone. The problem is, why do so few of these South American birds range northward and westward through a continuous rain forest, when they encounter no competition with a new group of species and genera? The point here is that the other birds in the rain forests of eastern Panama, are widely ranging types found from northern Central America to west Ecuador. In other words they are just as characteristic of the Colombian-Pacific Fauna as they are of Central America or the Isthmus of Panama.

There are two approaches to this problem. Both Dr. Chapman and I have attacked it from the historical side. We agree that the Colombian-Pacific Fauna was originally derived from the east, and that it spread northward into Central America. It is theoretically quite plausible that this invasion was pre-Glacial, that the refrigeration of the Ice Age caused a southward regression, thus accounting for the great concentration in western Colombia, and the steady decrease northward of all these characteristic rain forest types in Central America (cf. Birds of Guatemala, pp. 43–44). The very small number of endemic species in Central America would be explained as due to the small number of species, surviving the refrigeration, that remained. Theories such as this can be endorsed and validated, they can be justified, but never really proved.

The other approach is a study of the life history of the birds themselves, and this might give us another kind of answer. I should like to give some illustrations of the points involved. In the rain forests of Caribbean Central America there is a common and conspicuous Oropendola, *Gymnostinops montezuma*, which ranges south to the Canal Zone. In eastern Darien it is replaced by the equally large and conspicuous *G. guatimozinus*. Though the forest is continous, no *Gymnostinops* occurs in the intervening hundred miles. What, so to speak, is the matter with this forest? Why does not *montezuma* range east of the Canal Zone, or *guatimozinus* west of the Upper Tuyra?

One of the commonest rain forest birds of Central America is the little manakin, *Pipra mentalis*. It is abundant south to the Canal Zone, but while ranging south to west Ecuador as to the race *minor*, it is a rare and little known bird, less than twenty specimens being on record. In eastern Darien we encounter *Pipra erythrocephala*, which is abundant south to west Ecuador. In the area where the two species occur together, no one knows how they divide the territory between them. Let us contrast the manakins with two common Antbirds. *Myrmeciza exsul* is common in southern Central America, common in the Canal Zone, and common down the whole Caribbean slope of eastern Panama. On the Pacific side of eastern Darien we encounter *M. maculifer cassini*, which is equally common south into Colombia. We shall now ascend the Rio Chiman, half way between the Canal Zone and eastern Darien, and plunge into the heavy rain forest. We find *Pipra erythrocephala* as common as further east and no trace of *mentalis minor*. On the other hand we find *Myrmeciza exsul* as common as further west and no trace of *maculifer cassini!*

It will be apparent that we have here three strikingly contrasted

cases, behaving in three different ways in the same stretch of rain forest. It is inconceivable that the same theoretical historical explanation can account for the differences in these three cases. There are unknown factors in the varying life histories of these three pairs of species awaiting study. We have here a fertile field of research for the ornithologist of the future, which will endure long after the faunalist has added the last bird to the "Panama list", long after the explorer has discovered the last "new species", and long after we systematists have stopped wrangling over the "validity" of various subspecies, and have finally agreed as to whether certain birds are specifically or only subspecifically distinct. In other words the birds will then be studied before rather than after being shot. I hope indeed that this brief discussion will succeed in arousing some interest in this phase of geographical distribution. It is a novel one in dealing with Neotropical birds, and I am not aware that it has been brought out before. The avian zoögeographer, in dealing with two different faunas, has usually been able to show as a result of his field experience, that their distinctness is due to or correlated with obvious climatic, ecological or altitudinal barriers. Certainly the great rain forest belt of middle America, with one-third of the species confined to the extreme southern end, a bare sixth confined to the Central American end, and the remaining half ranging into both ends is without parallel in other sections of Central America.

2. Characteristic South American birds of more open woodlands.

Odontophorus guianensis marmoratus — extends to Canal Zone
Forpus conspicillatus conspicillatus
Anthracothorax nigricollis nigricollis — extends to Canal Zone
Momotus subrufescens conexus — extends to Canal Zone
Piculus chrysochlorus aurosus
Chrysoptilus punctigula lucescens
Thamnophilus nigriceps
Herpsilochmus rufimarginatus exiguus
Myrmeciza longipes panamensis — extends to Canal Zone
Pachyramphus rufus — extends to Canal Zone
Platypsaris homochrous — extends to Canal Zone
Fluvicola pica pica
Coryphotriccus parvus albovittatus — extends to Canal Zone
Phylloscartes ventralis flavovirens — extends to Canal Zone
Donacobius atricapillus brachypterus
Hylophilus minor darienensis
Ateleodacnis leucogenys panamensis

Molothrus bonariensis aequatorialis
Icterus auricapillus
Eucometis cristata cristata

The birds in this list are much easier to explain than those of the rain forest, and the avian zoögeographer returns to familiar ground. The relatives of these birds must be sought in similar habitats. We consequently find them in the Cauca-Magdalena Fauna, and chiefly in the more arid division of it. They are lacking in the intensely humid Colombian-Pacific Fauna. Their distribution is, consequently, essentially *discontinuous*. This accounts for the small number in eastern Panama, and also for the higher percentage which extends west into the savannas of Chepo or Panama City. It is this group of South American birds, which furnish us with our best clue to the origin and relationships of the peculiar birds of the Pacific slope of western Panama, which I discussed on an earlier page. Thus the *Odontophorus* is represented by the race *castigatus* in western Panama; *Thamnophilus nigriceps* by *T. bridgesi;* and *Eucometis cristata* by *E. spodocephala*. There are the usual anomalies of variation. Why should there be two distinct species of *Thamnophilus* when *Cercomacra nigricans*, the only other Ant-Shrike, is common to both regions without racial variation? We shall probably never know the answer to such questions. Perhaps the most remarkable bird in eastern Panama is the motmot, *Momotus subrufescens*. It is the only bird of Panama the racial variations of which are ecological rather than geographical. The paler *conexus* occurs commonly in the drier and open woodlands, and the darker, more richly colored *reconditus* is equally common in the dark heavy rain forest. Neither has a geographic range in the ordinary sense of the word, but the two are so distinct that they can be told apart in life.

As promised in earlier pages, I conclude this brief account of the birds of the Tropical Zone of Panama, with a table of the widely ranging birds of the humid tropics, which occur both in Central America and in eastern Panama and South America. A third column is appended for those cases where the species is represented in the forests of the Pacific slope of western Panama. My readers can see for themselves how few there are proportionately.

Caribbean Central America	Pacific Western Panama	Colombia and, or Eastern Darien
Tinamus major fuscipennis	*castaneiceps*	*saturatus*
Crypturellus soui modestus	*panamensis*	*harterti*
Accipiter superciliosus exitiosus	.....	*exitiosus*

Leucopternis semiplumbea	.....	*semiplumbea*
Leucopternis plumbea	.....	*plumbea*
Geranospiza nigra nigra	.....	*balzarensis*
Columba nigrirostris	.....	*nigrirostris*
Leptotila plumbeiceps notius	*malae*	*subsp.*
Oreopeleia veraguensis	.....	*veraguensis*
Threnetes ruckeri ventosus	*ventosus*	*darienensis*
Phoethornis superciliosa cephala	*cephala*	*cassini*
Phoethornis longuemarea saturata	*saturata*	*subrufescens*
Thalurania colombica venusta	*venusta*	*fannyi*
Chalybura urochrysa isaurae	.....	*incognita*
Trogon violaceus concinnus	*concinnus*	*caligatus*
Baryphthengus martii semirufus	.....	*semirufus*
Jacamerops aurea penardi	.....	*penardi*
Monasa morphœus grandior	.....	*pallescens*
Pteroglossus torquatus	*frantzii*	*torquatus*
Selenidera spectabilis	.....	*spectabilis*
Centurus pucherani	*chrysauchen*	*pucherani*
Celeus loricatus diversus	.....	*mentalis*
Cymbilaimus lineatus fasciatus	.....	*fasciatus*
Thamnistes anabatinus saturatus	*saturatus*	*coronatus*
Dysithamnus mentalis septentrionalis	.....	*suffusus*
Dysithamnus p. puncticeps	.....	*intensus*
Myrmotherula fulviventris	.....	*fulviventris*
Myrmotherula axillaris albigula	.....	*albigula*
Myrmotherula s. schisticolor	.....	*schisticolor*
Microrhopias boucardi virgata	*virgata*	*consobrina*
Myrmeciza l. laemosticta	.....	*palliata*
Myrmeciza exsul exsul	*occidentalis*	*maculifer cassini*
Formicarius analis umbrosus	*hoffmanni*	*panamensis*
Hylophylax naevioides capnitis	.....	*naevioides*
Phaenostictus mcleannanni saturatus	.....	*chocoanus*
Pittasoma michleri zeledoni	.....	*michleri*
Grallaria fulviventris flammulatus	.....	*barbacoae*
Grallaria perspicillata intermedia	*perspicillata*	*perspicillata*
Synallaxis brachyura nigrifumosa	.....	*chapmani*
Automolus o. hypophaeus	*exsertus*	*pallidigularis*
Sclerurus mexicanus pullus	.....	*andinus*
Xiphorhynchus guttatus costaricensis	*marginatus*	*nanus*
Xiphorhynchus l. lachrymosus	*lachrymosus*	*lachrymosus*
Xiphorhynchus erythropygius punctigulus	.....	*insolitus*
Deconychura typica subsp.	*typica*	*darienensis*
Pipra coronata velutina	*velutina*	*minuscula*
Pipra mentalis ignifera	*ignifera*	*minor*
Corapipo a. altera	*heteroleuca*	*altera*

Manacus cerritus	*M. aurantiacus*	*M. vitellinus*
Cotinga amabilis	*C. ridgwayi*	*C. nattereri*
Colonia colonus leuconota	.....	*leuconota*
Myiozetetes granadensis	.....	*granadensis*
Platyrinchus cor. superciliaris	*mystaceus neglectus*	*cor. superciliaris*
Tolmomyias flavotectus	.....	*flavotectus*
Todirostrum nigriceps	.....	*nigriceps*
Perissotriccus atricapillus	.....	*atricapillus*
Mecocerculus s. superciliaris	.....	*palloris*
Microtriccus b. brunneicapillus	.....	*brunneicapillus*
Stelgidopteryx ruficollis uropygialis	*decolor*	*uropygialis*
Thryothorus atrogularis	.....	*T. spadix*
Henicorhina leucosticta tropaea	*pittieri*	*darienensis*
Cyphorhinus phaeocephalus infuscatus	.....	*lawrencii*
Microbates cin. semitorquatus	.....	*cinereiventris*
Phaeothlypis l. leucopygia	*veraguensis*	*semicervina*
Icterus mesomelas salvini	.....	*salvini*
Chlorothraupis c. carmioli	.....	*lutescens*
Habia f. fuscicauda	.....	*erythrolaema*
Mitrospingus cassini costaricensis	.....	*cassini*
Cyanocompsa cyanoides caerulescens	*caerulescens*	*cyanoides*
Pitylus grossus saturatus	.....	*grossus*
Saltator maximus magnoides	*intermedius*	*iungens*
Arremonops striaticeps richmondi	*richmondi*	*striaticeps*
Arremon aurentiirostris rufidorsalis	*aurantiirostris*	*strictocollaris*

DISTRIBUTIONAL CHECK LIST OF PANAMA BIRDS

In the pages that follow I list 1038 species and subspecies, surely one of the most concentrated avifaunas in the world, in a region of so relatively little diversity. Panama, for instance, cannot compare with Colombia either in area or variety of terrain. The latter country has three great ranges of mountains, with three subtropical zones, three temperate zones, considerable paramo zone, and isolated areas of both humid and arid tropics, all features lacking in Panama. For the sake of brevity, the term "mountains" (often abbreviated to mts.) is taken to mean the Subtropical Zone, unless some special qualification implies or indicates the Temperate Zone. Where nothing is said about mountains, the Tropical Zone is to be understood.

There are bound to be a certain number of cases where there will be disagreement among my colleagues with regard to genera recognized, questions of specific versus racial distinctness, and the validity of

races recognized or not recognized. Where this disagreement has been published, I have endeavored to defer to it in those cases where my critic has seen better material than I. In those cases, however, where they have not, and the material examined by them has not been supplemented by personal experience in the field with the complicated topographic and climatic variations in Central America, I have not hesitated to differ from them. I trust they will remember that the points involved are really matters of minute systematic or taxonomic detail. This check-list is not a systematic critique; its object is to render available in one paper the enormous number of birds already found in the Republic of Panama, together with some idea of their distributional features. Some of the races listed will undoubtedly be reduced to synonymy when better series become available, and the same increase of material will undoubtedly result in the description of others.

Every endeavor has been made to keep the list up to date, and constant revision has been made for years in nomenclature and taxonomic questions, as paper after paper and collection after collection has been read or examined. It is hoped that few errors of either commission or omission have been made, though some would seem almost inevitable. In any case the student of Neotropical birds in general and of Panama birds in particular will at least know what bird I am talking about, even if I have overlooked the latest proposed name, even if he thinks the subspecies is no good, or if he thinks that it is better treated as a distinct species or a race of some other species.

I have, however, made no original changes in this paper. Current names are maintained. Currently recognized genera are used, even when I do not believe in them. I combine no species for the first time. Changes such as these should at least be accompanied with the reasons for doing so, and there is no room in a check-list for this type of discussion.

ORDER TINAMIFORMES

FAMILY TINAMIDAE — Tinamous

Tinamus major fuscipennis Salvadori

Range. — Caribbean slope of Central America, Nicaragua to Canal Zone.

Panama. — Caribbean slope of western Panama, Almirante to Canal Zone.

Tinamus major castaneiceps Salvadori
Range. — Pacific slope, s. w. Costa Rica to eastern Panama.
Panama. — Pacific slope, Chiriqui to eastern limits of Arid Tropical Zone (Rio Chiman, Cape Garachiné).

Tinamus major saturatus Griscom
Range. — Humid Tropical Zone of eastern Panama, both slopes.

Nothocercus bonapartei frantzii (Lawrence)
Range. — Subtropical Zone, mts. of Costa Rica and w. Panama.
Panama. — Volcan de Chiriqui (no recent records).

Crypturellus soui modestus (Cabanis)
Range. — Costa Rica and part of Chiriqui.
Panama, — Pacific slope of Chiriqui.

Crypturellus soui panamensis (Carriker)
Range. — Arid Tropical Zone, Pacific slope of Panama from Veraguas to eastern limits of this Zone at Cape Garachiné.

Crypturellus soui harterti (Brabourne & Chubb)
Range. — West Ecuador to western Panama.
Panama. — Humid Tropical Zone, entire Caribbean slope and parts of Pacific slope of extreme eastern Darien in this Zone.

ORDER COLYMBIFORMES

FAMILY COLYMBIDAE — Grebes

Poliocephalus dominicus brachypterus (Chapman). Least Grebe
Range. — Texas to western Panama.
Panama. — Locally in ponds and lakes (Almirante, Canal Zone).

Podilymbus podiceps podiceps (Linnaeus). Pied-billed Grebe
Range. — North and Central America, wintering southward.
Panama. — Veraguas (Laguna de Castillo); Almirante; Canal Zone.

ORDER PROCELLARIIFORMES

FAMILY DIOMEDIIDAE — Albatrosses

Diomedea chrysostoma Forster. Gray-headed Albatross
Range. — Southern oceans.
Panama. — Off coast of Chiriqui (once).

FAMILY PROCELLARIIDAE — Shearwaters

Puffinus tenuirostris tenuirostris (Temminck). Slender-billed Shearwater
Range. — Southern oceans, wandering north to Bering Sea.
Panama. — Off Naos Island, Bay of Panama (once).

[*Puffinus lherminieri lherminieri* Lesson
Recorded in Salvadori's report on Festa's Panama birds, as captured at sea 300 miles from Colon. This cannot be regarded as a Panama record!]

FAMILY HYDROBATIDAE — Petrels

Oceanodroma melania melania (Bonaparte). Black Petrel
Range. — Islands off w. Mexico, wintering at sea southward.
Panama. — Bay of Panama (Hallinan, Griscom).

Halocyptena microsoma Coues. Least Petrel
Range. — San Benito Isl., Lower California, wintering southward.
Panama. — Bay of Panama (Townsend, Griscom).

ORDER PELECANIFORMES

FAMILY PHAËTHONTIDAE — Tropic Birds

Phaëthon aethereus mesonauta Peters
Range. — Locally off w. Mexico and in Caribbean Sea.
Panama. — Breeds on Swan Key, Bocas del Toro.

FAMILY PELECANIDAE — Pelicans

Pelecanus occidentalis occidentalis Linnaeus. Brown Pelican
Range. — West Indies and Caribbean Sea.
Panama. — Off entire Caribbean coast.

Pelecanus occidentalis californicus Ridgway. California Pelican
Range. — California to Galapagos.
Panama. — Off entire Pacific coast, breeding abundantly.

FAMILY SULIDAE — Boobies

Sula nebouxii Milne-Edwards. Blue-footed Booby
Range. — Mexico to northern Peru.
Panama. — Pearl Islands (breeding).

Sula dactylatra dactylatra Lesson. Blue-faced Booby
Range. — West Indies and Caribbean Sea.
Panama. — Common off Caribbean coast.

Sula sula sula (Linnaeus). Red-footed Booby
Range. — Tropical Atlantic.
Panama. — Colon Harbor (Griscom & Crosby). [1]

Sula leucogaster leucogaster (Boddaert). Booby
Range. — Tropical Atlantic.
Panama. — Off Caribbean coast (Almirante; Colon Harbor).

Sula leucogaster etesiaca Thayer and Bangs
Range. — Pacific coast of Central and northern South America.
Panama. — Off whole Pacific coast; breeds abundantly Pearl Islands.

FAMILY PHALACROCORACIDAE — Cormorants

Phalacrocorax olivaceus olivaceus (Humboldt). Mexican Cormorant
Range. — Warmer parts of New World.
Panama. — Common throughout.

FAMILY ANHINGIDAE — Darters

Anhinga anhinga (Linnaeus). Snake-Bird
Range. — Warmer parts of New World.
Panama. — Locally throughout; chiefly larger coastal rivers.

FAMILY FREGATIDAE — Frigate Birds

Fregata magnificens magnificens Mathews
Range. — Eastern Tropical Pacific.
Panama. — Off Pacific coast; breeds abundantly Pearl Islands.

Fregata magnificens rothschildi Mathews
Range. — Western tropical Atlantic.
Panama. — Common off Caribbean coast.

[1] Sight records only.

ORDER CICONIIFORMES

FAMILY ARDEIDAE — Herons, Egrets, Bitterns

Ardea herodias[1] *herodias* Linnaeus. Great Blue Heron
Range. — Eastern North America, south in winter to Colombia.
Panama. — Fairly common in winter throughout.

Pilherodius pileatus (Boddaert)
Range. — Panama to Brazil.
Panama. — Canal Zone (1 record); eastern Darien (2 records).

Butorides virescens virescens (Linnaeus). Green Heron
Range. — Eastern North America, south in winter to Colombia.
Panama. — Winter visitant throughout.

Butorides virescens maculatus (Boddaert)
Range. — Resident in West Indies and Central America.
Panama. — Local colonies almost throughout; strictly coastal.

Butorides virescens margaritophilus Oberholser
Range. — Endemic on the Pearl Islands, Bay of Panama.

Butorides striatus patens Griscom
Range. — Known only from the Canal Zone.

Butorides striatus striatus (Linnaeus)
Range. — Panama to Brazil.
Panama. — Cana, eastern Darien (one specimen).

Florida caerulea (Linnaeus). Little Blue Heron
Range. — Warmer parts of New World.
Panama. — Common throughout.

Casmerodius albus egretta (Gmelin). American Egret
Range. — Same as last.
Panama. — Throughout; now local and uncommon.

Leucophoyx thula thula (Molina). Snowy Egret
Range. — Same as last.
Panama. — Throughout; now rare and local.

Hydranassa tricolor ruficollis (Gosse). Louisiana Heron
Range. — Southern U. S. to Ecuador.
Panama. — Common throughout.

[1]Some form has been found breeding in the Canal Zone.

Agamia agami (Gmelin). Agami Heron
Range. — Tropical America, in humid forests only.
Panama. — Rare and local; very few records.

Nycticorax nycticorax hoactli (Gmelin). Black-crowned Night Heron
Range. — United States to Argentina; local in the tropics.
Panama. — Canal Zone, and Rio Chepo (Smith).

Nyctanassa violacea violacea (Linnaeus). Yellow-crowned Night Heron
Range. — United States and Central America.
Panama. — Locally common throughout.

Tigrisoma lineatum lineatum (Boddaert). Banded Tiger Bittern
Range. — Nicaragua to northern South America.
Panama. — Throughout, in the Humid Tropical Zone.

Heterocnus cabanisi (Heine). Tiger Bittern
Range. — Central America.
Panama. — Recorded throughout, but chiefly Pacific coast.

Ixobrychus exilis erythromelas (Vieillot). Least Bittern
Range. — Panama and northern South America.
Panama. — Canal Zone (old breeding record).

Botaurus lentiginosus (Montagu). American Bittern
Range. — North America, in winter to Panama.
Panama. — Canal Zone (1 record).

FAMILY COCHLEARIIDAE — Boat-billed Herons

Cochlearius cochlearius panamensis Griscom
Range. — Southern Central America.
Panama. — Locally common throughout.

FAMILY CICONIIDAE — Storks

Mycteria americana Linnaeus. Wood Ibis
Range. — Warmer parts of New World.
Panama. — Locally throughout.

Jabiru mycteria (Lichtenstein). Jabiru
Range. — Tropical America; very local.
Panama. — One record (Cricamola, Wedel).

FAMILY THRESKIORNITHIDAE — Ibises and Spoonbills

Mesembrinibis cayannensis (Gmelin)
Range. — Panama to Argentina.
Panama. — Canal Zone (1 old record); Almirante region (Wedel).

Guara alba (Linnaeus). White Ibis
Range. — Warmer parts of New World.
Panama. — Throughout, but local.

Ajaia ajaja (Linnaeus). Roseate Spoonbill
Range. — Same as last; very local.
Panama. — Very locally throughout.

ORDER ANSERIFORMES

FAMILY ANATIDAE[1] — Ducks, Geese, Swans

Dendrocygna viduata (Linnaeus)
Range. — Tropical South America, north to Costa Rica.
Panama. — Canal Zone (1 shot).

Dendrocygna autumnalis autumnalis (Linnaeus). Black-bellied Tree-Duck
Range. — Texas to the Canal Zone.
Panama. — Western half; very local; passing into

Dendrocygna autumnalis discolor Sclater & Salvin
Range. — Tropical South America.
Panama. —Darien (Permé).

Cairina moschata (Linnaeus). Muscovy Duck.
Range. — Tropical America.
Panama. — Throughout, but exceedingly local.

Anas platyrhynchos platyrhynchos Linnaeus. Mallard
Range. — North America, south in winter to Panama.
Panama. — Canal Zone (2 records).

Anas cyanoptera cyanoptera Vieillot. Cinnamon Teal
Range. — Locally from western U. S. to Argentina.
Panama. — Canal Zone (1 shot).

[1]Conversation with sportsmen in the Canal Zone indicates that North American ducks are of far more frequent occurrence than the few records given below would indicate.

Anas discors Linnaeus. Blue-winged Teal
Range. — North America, south in winter to Colombia.
Panama. — Fairly common in winter locally.

Anas acuta tzitzihoa Vieillot. Pintail
Range. — North America, south in winter to Panama.
Panama. — Canal Zone (once).

Mareca americana (Gmelin). Baldpate
Range. — North America, south in winter to Panama.
Panama. — Canal Zone (once).

Spatula clypeata (Linnaeus). Shoveller
Range. — North America, south in winter to Colombia.
Panama. — Once (Divalá, Chiriqui).

Nyroca affinis (Eyton). Lesser Scaup
Range. — North America, south in winter to Colombia.
Panama. — Veraguas (Arcé); Canal Zone (regular).

Nomonyx dominicus (Linnaeus). Masked Duck
Range. — Tropical America, very local.
Panama. — Veraguas (Arcé); Canal Zone; Darien (Festa).

ORDER FALCONIFORMES

FAMILY CATHARTIDAE — Vultures

Sarcorhamphus papa (Linnaeus). King Vulture
Range. — Tropical America.
Panama. — Throughout, but uncommon.

Coragyps atratus (Bechstein). Black Vulture
Range. — Warmer parts of New World.
Panama. — Throughout, abundant.

Cathartes aura aura[1] (Linnaeus). Turkey Vulture
Range. — Middle America.
Panama. — Throughout, common, not typical of any subspecies.

FAMILY ACCIPITRIDAE — Hawks, Eagles, etc.

Elanoides forficatus yetapa (Vieillot). Swallow-tailed Kite
Range. — Tropical America.
Panama. — Common throughout.

[1]Birds from eastern Panama are perhaps referable to a South American race.

Odontriorchis palliatus (Temminck)
Range. — Tropical America, local.
Panama. — Very local in swamps and marshes.

Chondrohierax uncinatus uncinatus (Temminck)
Range. — Tropical America, local.
Panama. — Very local in swamps and marshes.

Harpagus bidentatus fasciatus Lawrence
Range. — Central America.
Panama. — Throughout, rare and local.

Ictinia plumbea (Gmelin)
Range. — Tropical America.
Panama. — Common throughout; partly migratory.

Rostrhamus sociabilis sociabilis (Vieillot). Everglade Kite
Range. — Tropical South America; very local.
Panama. — Obaldia, eastern Darien (Wedel).

Accipiter bicolor bicolor (Vieillot)
Range. — Mexico to Ecuador.
Panama. — Throughout, but uncommon.

Accipiter superciliosus exitiosus Bangs & Penard
Range. — Costa Rica to Colombia; very rare.
Panama. — Humid Tropical Zone, 3 records.

Accipiter striatus velox (Wilson). Sharp-shinned Hawk
Range. — North America, south in winter to Panama.
Panama. — Volcan de Chiriqui (once).

Heterospizias meridionalis meridionalis (Latham)
Range. — Panama to Paraguay.
Panama. — Savannas, Chiriqui and Veraguas, Pacific slope.

Buteo albicaudatus hypospodius Gurney. White-tailed Hawk
Range. — U. S. A. to Colombia.
Panama. — Veraguas (Arcé).

Buteo jamaicensis costaricensis Ridgway. Red-tailed Hawk
Range. — Mts. of Central America.
Panama. — Mts. of Veraguas.

Buteo albonotatus albonotatus Kaup
Range. — Southern U. S., south in winter to Panama.
Panama. — Permé, eastern Darien (Wedel).

Buteo albonotatus abbreviatus Cabanis[1]
Range. — Panama to Guiana.
Panama. — Pearl Islands (Brown).

Buteo swainsoni Bonaparte. Swainson's Hawk
Range. — Western U. S. A., migrating to southern S. A.
Panama. — Passing over in enormous flocks; 1 specimen.

Buteo platypterus platypterus (Vieillot). Broad-winged Hawk
Range. — N. A., south in winter to S. A.
Panama. — Throughout on migration and in winter.

Buteo magnirostris argutus (Peters & Griscom)
Range. — Part of southern Central America.
Panama. — Caribbean slope of western Panama.

Buteo magnirostris ruficauda (Sclater & Salvin)
Range. — Pacific slope, Costa Rica and Panama.
Panama. — Whole Pacific slope, but only 1 record eastern Darien.[2]

Buteo magnirostris alius (Peters & Griscom)
Range. — El Rey Island, Pearl Islands.

Buteo magnirostris insidiatrix (Bangs & Penard)
Range. — Eastern Panama to northern Venezuela.
Panama. — Caribbean slope, Permé and Obaldia (Wedel).

Buteo brachyurus Vieillot
Range. — Tropical America; rare.
Panama. — Scattered records throughout.

Parabuteo unicinctus harrisi (Audubon)
Range. — Texas to western Ecuador, in open country.
Panama. — Santa Fé, Veraguas and Almirante (Wedel).

Asturina nitida costaricensis Swann
Range. — S. W. Costa Rica to Santa Marta.
Panama. — Little known; Pacific slope, Veraguas and Canal Zone; also Permé (Wedel).

Leucopternis albicollis costaricensis W. L. Sclater
Range. — Honduras to eastern Panama.
Panama. — Throughout.

[1]The relationships and boundaries of these two races still remain to be worked out.
[2]This bird will probably prove to belong to a Colombian race.

Leucopternis semiplumbea Lawrence
Range. — Nicaragua to west Ecuador in humid tropical forests; rare.
Panama. — Caribbean lowlands, 6 records.

Leucopternis plumbea Salvin
Range. — Panama to Ecuador; very rare.
Panama. — Veraguas (once); eastern Darien (Wedel).

Leucopternis princeps Sclater
Range. — Mts. of Costa Rica, western Panama and Ecuador, very rare.
Panama. — Caribbean slope of Volcan de Chiriqui (Kennard).

Hypomorphnus urubitinga ridgwayi (Gurney)
Range. — Mexico to western Panama.
Panama. — Cerro Flores, Chiriqui (Griscom); Canal Zone (1 spec.)

Hypomorphnus urubitinga urubitinga (Gmelin)
Range. — Most of Tropical South America.
Panama. — Permé (Wedel).

Buteogallus anthracinus anthracinus (Lichtenstein)
Range. — Texas to Panama.
Panama. — Western Panama to Canal Zone.

Buteogallus subtilis[1] (Thayer & Bangs)
Range. — Pacific coast, Salvador to Ecuador.
Panama. — Coastal mangrove swamps, Darien and Pearl Islands.

Busarellus nigricollis nigricollis (Latham)
Range. — Mexico to Brazil.
Panama. — Locally in swampy rivers; western part (Arcé) and Darien.

Urubitornis solitaria (Tschudi)
Range. — Mexico to Chile; rare and little known.
Panama. — Veraguas (once).

Morphnus guianensis (Daudin). Crested Eagle
Range. — Honduras to Paraguay in rain forest.
Panama. — Almirante (1 record); Canal Zone (once); Darien (several records).

[1]probably a race of *anthracinus*.

Morphnus taeniatus Gurney
Range. — Eastern Ecuador and eastern Panama; only 3 specimens known.
Panama. — Permé (Wedel).

Harpia harpyja (Linnaeus). Harpy Eagle.
Range. — Mexico to Argentina.
Panama. — Scattered records from the tropical rain forest areas.

Spizastur melanoleucus (Vieillot)
Range. — Tropical America; rare.
Panama. — Four scattered records.

Spizaëtus ornatus (Daudin)
Range. — Tropical America; uncommon.
Panama. — Scattered records throughout.

Spizaëtus tyrannus (Wied.)
Range. — Mexico to Brazil; rare.
Panama. — Veraguas (once); Canal Zone (once); Darien.

Circus cyaneus hudsonius (Linnaeus). Marsh Hawk
Range. — North America, south in winter to Colombia.
Panama. — Recorded throughout.

Geranospiza nigra nigra (Du Bus). Crane Hawk
Range. — Mexico to Panama; rare.
Panama. — Heavy forest east to Canal Zone.

Geranospiza nigra balzarensis W. L. Sclater
Range. — Panama to west Ecuador.
Panama. — Extreme eastern Darien.

Pandion haliaëtus carolinensis (Gmelin). Fish Hawk; Osprey
Range. — North America, south in winter to Argentina.
Panama. — Both coasts throughout in winter.

FAMILY FALCONIDAE

Herpetotheres cachinnans cachinnans (Linnaeus). Laughing Falcon
Range. — Mexico to South America.
Panama. — Western half and Caribbean slope of eastern half.

Herpetotheres cachinnans fulvescens Chapman.
Range. — Panama to west Ecuador.
Panama. — Pacific slope of Darien.

Micrastur semitorquatus naso (Lesson)
Range. — Mexico to Colombia; rare.
Panama. — Scattered records from the humid tropical forests.

Micrastur mirandollei (Schlegel)
Range. — Costa Rica to Brazil; very rare.
Panama. — Scattered records from Caribbean slope; one from Pacific slope.

Micrastur ruficollis interstes Bangs
Range. — Costa Rica to Ecuador; uncommon.
Panama. — Throughout.

Daptrius americanus guatemalensis (Swann)
Range. — Guatemala to the Canal Zone.
Panama. — Throughout western half.

Daptrion americanus americanus (Boddaert)
Range. — Panama to Brazil.
Panama. — Extreme eastern Panama.

Milvago chimachima cordatus Bangs & Penard
Range. — Panama to Guiana.
Panama. — Arid tropical areas on Pacific slope.

Polyborus cheriway cheriway (Jacquin). Caracara
Range. — Panama to Peru and Guiana.
Panama. — Pearl Islands and Darien.

Polyborus cheriway audubonii Cassin. Audubon's Caracara
Range. — Southern U. S. to Panama.
Panama. — Western half, arid tropics.

Falco peregrinus anatum Bonaparte. Duck Hawk
Range. — North America, south in winter to South America.
Panama. — Veraguas (once); Changuinola (Wedel).

Falco deiroleucus Temminck
Range. — Tropical America; very rare.
Panama. — Chiriqui (Arcé); Veraguas (Griscom).

Falco albigularis Daudin. Bat Falcon
Range. — Tropical America.
Panama. — Throughout.

Falco fuscocaerulescens fuscocaerulescens Vieillot
Range. — Panama and most of South America.
Panama. — Arid plains of Agua Dulce.

Falco columbarius columbarius Linnaeus. Pigeon Hawk
Range. — Eastern N. A., south in winter to South America.
Panama. — Throughout in winter.

Falco sparverius sparverius Linnaeus. Sparrow Hawk
Range. — North America, to Panama in winter.
Panama. — Common in winter throughout.

ORDER GALLIFORMES

FAMILY CRACIDAE — Curassows, Guans, Chachalacas

Crax rubra rubra Linnaeus
Range. — Mexico to west Ecuador, a race on Cozumel Island.
Panama. — Throughout.

Penelope purpurascens aequatorialis Salvadori
Range. — Costa Rica to west Ecuador.
Panama. — Throughout.

Ortalis garrula mira Griscom
Range. — Known only from Caribbean slope, eastern Darien.

Ortalis garrula cinereiceps (Gray)
Range. — Costa Rica to western Colombia.
Panama. — Common almost throughout.

Chamaepetes unicolor Salvin
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of western half.

FAMILY PERDICIDAE — Partridges, Quail

Colinus cristatus panamensis Dickey & van Rossem
Range. — Arid plains of Veraguas and Coclé only.

Odontophorus guianensis castigatus Bangs
Range. — Coastal forests of western Chiriqui.

Odontophorus guianensis marmoratus Gould
Range. — Eastern Panama and Colombia.
Panama. — Canal Zone eastward; common.

Odontophorus melanotis coloratus Griscom
Range. — Caribbean slope of western Panama.

Odontophorus leucolaemus Salvin (including *smithians* Oberholser)
Range. — Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Odontophorus guttatus (Gould) (including *veraguensis* Gould)
Range. — Mexico to west Panama.
Panama. — Volcan de Chiriqui above 5000 ft.

Rhynchortyx cinctus cinctus (Salvin)
Range. — Rain forest, Nicaragua to Colombia.
Panama. — Pacific slope, Veraguas (very rare), Darien (common).

Rhynchortyx cinctus hypopius Griscom
Range. — Caribbean slope, eastern Darien.

ORDER GRUIFORMES

FAMILY RALLIDAE

Aramides axillaris Lawrence
Range. — Mexico to west Ecuador; very rare.
Panama. — Almirante (Wedel).

Aramides cajanea cajanea (P. L. S. Muller)
Range. — Panama to Guiana.
Panama. — Common throughout.

Aramides cajanea latens Bangs
Range. — Pearl Islands.

Amaurolimnas concolor guatemalensis (Lawrence)
Range. — Guatemala to west Ecuador; very rare.
Panama. — Chiriqui (once); Almirante (Wedel).

Porzana carolina (Linnaeus)
Range. — North America, south in winter to Ecuador.
Panama. — Several records, east to the Canal Zone.

Laterallus albigularis cinerciceps (Lawrence)
Range. — Nicaragua to west Panama.
Panama. — Caribbean slope, east to Rio Calovevora.

Laterallus albigularis albigularis (Lawrence)
Range. — Panama to west Ecuador.
Panama. — Canal Zone eastward.

Gallinula chloropus cachinnans Bangs
Range. — North and Middle America, wintering southward.
Panama. — Almirante, Canal Zone.

Porphyrula martinica (Linnaeus)
Range. — Southern U. S. to Brazil.
Panama. — Locally throughout.

Fulica americana americana Gmelin
Range. — North and Middle America.
Panama. — Veraguas (Arcé); Chiriqui Lagoon (resident).

FAMILY HELIORNITHIDAE — Finfeet

Heliornis fulica (Boddaert)
Range. — Tropical America; very local.
Panama. — Almirante region; Chagres River; Lake Gatun.

FAMILY EURYPYGIDAE — Sun Bitterns

Eurypyga helias major Hartlaub
Range. — Guatemala to Peru; rare.
Panama. — Scattered records from tropical rain forest areas.

ORDER CHARADRIIFORMES

FAMILY JACANIDAE — Jacanas

Jacana spinosa spinosa (Linnaeus)
Range. — Guatemala to west Panama.
Panama. — Chiriqui (Pacific slope east to Remedios); Almirante.

Jacana hypomelaena (G. R. Gray)[1]
Range. — Panama and northern South America.
Panama. — Veraguas eastward; common.

[1]According to Peters, Birds World, **2**, p. 229, a race of *spinosa*. The two birds occur commonly together, however, in the same pool at Remedios, without producing intermediates. *Hypomelaena* is either a distinct species or a local melanism not entitled to taxonomic recognition.

FAMILY HAEMATOPODIDAE — Oyster-catchers

Haematopus ostralegus palliatus Temminck
Range. — Locally from southern U. S. to Panama.
Panama. — Veraguas[1] (Arcé); resident on Pearl Islands.

FAMILY CHARADRIIDAE — Plover, etc.

Charadrius semipalmatus Bonaparte. Ring-neck
Range. — Arctic, south in winter to South America.
Panama. — Common in winter throughout.

Charadrius collaris Vieillot
Range. — Tropical America; local.
Panama. — Canal Zone.

Charadrius wilsonia beldingi (Ridgway)
Range. — Pacific coast, Lower California to Peru.
Panama. — Panama City and Pearl Islands.

Charadrius vociferus vociferus Linnaeus. Killdeer
Range. — U. S., south in winter to Ecuador.
Panama. — Common in winter in unforested country.

Squatarola squatarola (Linnaeus). Black-bellied Plover
Range. — Arctic, far south in winter.
Panama. — Common in winter.

Arenaria interpres morinella (Linnaeus). Ruddy Turnstone
Range. — Arctic, far south in winter.
Panama. — Veraguas (Arcé); Canal Zone.

FAMILY SCOLOPACIDAE — Snipe, Sandpipers

Capella delicata (Ord). Wilson's Snipe
Range. — Northern N. A., far southward in winter.
Panama. — Regular in winter to all favorable localities.

Numenius (*Phœopus*) *hudsonicus* Latham. Hudsonian Curlew
Range. — Arctic, far southward in winter.
Panama. — Common in winter.

[1]Probably not *palliatus*.

Bartramia longicauda (Bechstein). Upland Plover
Range. — U. S., wintering south of Equator.
Panama. — Chiriqui and Canal Zone on migration.

Actitis macularia (Linnaeus). Spotted Sandpiper
Range. — N. A., wintering far southward.
Panama. — Abundant in winter throughout.

Catoptrophorus semipalmatus inornatus (Brewster). Western Willet
Range. — Western U. S., south in winter to Peru.
Panama. — Common throughout in winter.

Tringa solitaria solitaria Wilson. Solitary Sandpiper
Range. — Northern North America, far south in winter.
Panama. — Common in winter throughout.

Tringa melanoleuca (Gmelin). Greater Yellowlegs
Range. — Arctic, far south in winter.
Panama. — Common in winter throughout.

Tringa flavipes (Gmelin). Lesser Yellowlegs
Range. — Same as last.
Panama. — Agua Dulce; Canal Zone.

Erolia melanotos (Vieillot). Pectoral Sandpiper
Range. — Same as last.
Panama. — Canal Zone on migration.

Erolia fuscicollis (Vieillot). White-rumped Sandpiper
Range. — Same.
Panama. — Canal Zone on migration.

Erolia bairdi (Coues). Baird's Sandpiper
Range. — Same.
Panama. — Canal Zone on migration (once).

Erolia minutilla (Vieillot). Least Sandpiper
Range. — Same.
Panama. — Common in winter throughout.

Limnodromus griseus griseus (Gmelin). Dowitcher
Range. — Same.
Panama. — Canal zone (once); Permé (Wedel).

Limnodromus griseus scolopaceus (Say). Long-billed Dowitcher
Range. — Same, but more westerly.
Panama. — Agua Dulce.

Ereunetes pusillus (Linnaeus). Semipalmated Sandpiper
Range. — Same.
Panama. — Probably common in winter throughout.

Ereunetes mauri Cabanis. Western Sandpiper
Range. — Same, but more westerly.
Panama. — Abundant in winter on Pacific coast.

Tryngites subruficollis (Vieillot). Buff-breasted Sandpiper
Range. — Same; rare species.
Panama. — Canal Zone on migration.

Himantopus mexicanus (Muller). Black-necked Stilt
Range. — Western U. S., south in winter to South America.
Panama. — Canal Zone.

FAMILY OEDICNEMIDAE — Thick-knees

[*Burhinus bistriatus* subsp.
Panama. — Cage bird bought by Festa at Panama City, not definitely from any Panama locality.]

FAMILY STERCORARIIDAE — Skuas, Jaegers[1]

Stercorarius pomarinus (Temminck). Pomarine Jaeger
Range. — Arctic, far south in winter.
Panama. — Colon Harbor (Griscom & Crosby).

Stercorarius parasiticus (Linnaeus). Parasitic Jaeger
Range. — Same.
Panama. — Colon Harbor (Griscom & Crosby).

Stercorarius longicaudus Vieillot. Long-tailed Jaeger
Range. — Same.
Panama. — Colon Harbor (Griscom & Crosby).

FAMILY LARIDAE — Gulls, Terns

Larus argentatus smithsonianus Coues. Herring Gull
Range. — North America, to southern Mexico in winter.
Panama. — Accidental; Bocas del Toro, Dec. 10, 1933.

[1]Numerous sight records only. Jaegers sometimes enter Colon Harbor in numbers and become absolutely fearless, living on garbage and robbing the Laughing Gulls.

Larus atricilla Linnaeus. Laughing Gull.
Range. — U. S., south in winter to South America.
Panama. — Common off the coast and in the Canal.

Larus pipixcan Wagler. Franklin's Gull
Range. — Western N. A., south in winter to Peru.
Panama. — Canal Zone, once on migration.

Gelochelidon nilotica aranea (Wilson). Gull-billed Tern
Range. — Southern U. S., wandering far south in winter.
Panama. — Agua Dulce.

Sterna hirundo hirundo Linnaeus. Common Tern
Range. — N. A., wandering far south in winter.
Panama. — Canal Zone (2 records).

Sterna fuscata crissalis (Lawrence). Sooty Tern
Range. — Mexico to Galapagos.
Panama. — Canal Zone; Veraguas (Arcé).

Sterna anaetheta nelsoni Ridgway. Bridled Tern
Range. — Tropical eastern Pacific.
Panama. — One record at sea off Cape Mala.

Thalasseus maximus maximus (Boddaert). Royal Tern
Range. — Southern U. S., far southward in winter.
Panama. — Canal Zone and Panama Bay, common all winter.

Thalasseus sandvichensis acuflavidus (Cabot). Cabot's Tern
Range. — Southern U. S., far southward in winter.
Panama. — Darien, 2 records.

Chlidonias nigra surinamensis (Gmelin). Black Tern
Range. — Interior of N. A., south in winter to South America.
Panama. — Scattered records on migration.

FAMILY RYNCHOPIDAE — Skimmers

Rynchops nigra subsp.
Panama. — Off coast of Veraguas (Griscom).[1]

[1]Sight record only.

ORDER COLUMBIFORMES

FAMILY COLUMBIDAE — Pigeons, Doves

Columba leucocephala Linnaeus. White-crowned Pigeon
Range. — West Indies and islands off Central America.
Panama. — Swan Key, Bocas del Toro.

Columba speciosa Gmelin
Range. — Tropical America.
Panama. — Chiriqui, Veraguas, Canal Zone.

Columba rufina pallidicrissa Chubb
Range. — Mexico to Panama.
Panama. — Common throughout.

Columba albilinea crissalis Salvadori
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, Chiriqui and Veraguas.

Columba nigrirostris Sclater
Range. — Mexico to Colombia.
Panama. — Tropical rain forest throughout.

Columba subvinacea subvinacea Lawrence
Range. — Costa Rica and west Panama.
Panama. — Subtropical Zone, Chiriqui, Veraguas.

Columba subvinacea berlepschi Hartert
Range. — Panama to Ecuador.
Panama. — Mt. Tacarcuna.

Columba chiriquensis Ridgway
Panama. — One known specimen, "Chiriqui".[1]

Zenaidura macroura macroura (Linnaeus)
Range. — West Indies, and locally in Central America.
Panama. — Santiago, Veraguas (breeding 1925); Divalá, Chiriqui.

Zenaidura macroura carolinensis (Linnaeus). Mourning Dove.
Range. — Eastern U. S., south to Panama.
Panama. — Divala, Chiriqui (once).

Zenaidura macroura marginella (Woodhouse)
Range. — Western U. S., south to Panama.
Panama. — Regular in winter in western half.

[1]This region is now so well known, that the locality of the type is open to grave suspicion.

Melopelia asiatica australis Peters
Known only from Guanacaste, Costa Rica and Agua Dulce, Panama.

Columbigallina minuta elaeodes (Todd)
Range. — Costa Rica to Colombia.
Panama. — Pacific slope of western Panama, common.

Columbigallina rufipennis rufipennis (Bonaparte)
Range. — Mexico to northern S. A.
Panama. — Common throughout.

Claravis pretiosa pretiosa (Ferrari-Perez)
Range. — Tropical America.
Panama. — Tropical rain forest throughout.

Claravis mondetoura pulchra Griscom
Range. — Mts. of Costa Rica and west Panama; very rare.
Panama. — Subtropical Zone, Volcan de Chiriqui.

Leptotila verreauxi verreauxi (Bonaparte)
Range. — Nicaragua to northern South America.
Panama. — Common throughout, except in rain forest.

Leptotila cassini cassini (Lawrence)
Range. — Panama and northern South America.
Panama. — Common throughout in heavy tropical forest.

Leptotila rufinucha Sclater & Salvin
Range. — S. w. Costa Rica and west Panama.
Panama. — Pacific slope, Chiriqui and Veraguas.

Leptotila plumbeiceps notius Peters
Range. — Almirante region, west Panama.

Leptotila plumbeiceps malae Griscom
Range. — Interior of Cape Mala Peninsula, Veraguas.

Leptotila plumbeiceps battyi Rothschild
Panama. — Coiba Island only.

Oreopeleia montana (Linnaeus). Ruddy Quail Dove
Range. — Most of tropical America.
Panama. — In heavy forest throughout.

Oreopeleia violacea albiventer Lawrence
Range. — Nicaragua to Colombia; very rare.
Panama. — Canal Zone, Darien.

Oreopeleia veraguensis (Lawrence)
Range. — Costa Rica to Ecuador.
Panama. — Veraguas (very rare); Darien (not uncommon).

Oreopeleia costaricensis (Lawrence)
Range. — Costa Rica and western Panama; rare.
Panama. — Chiriqui and Veraguas in rain forest.

Oreopelcia lawrencei lawrencei (Salvin)
Range. — Caribbean slope of western Panama to Veraguas; very rare.

Oreopeleia goldmani (Nelson)
Range. — Subtropical Zone, mts. of eastern Darien.

Oreopeleia chiriquensis (Sclater)
Range. — Costa Rica and west Panama.
Panama. — Subtropical Zone, Pacific slope, mts. of Chiriqui and Veraguas; not uncommon.

ORDER CUCULIFORMES

FAMILY CUCULIDAE — Cuckoos, Anis, etc.

Coccyzus americanus americanus (Linnaeus)
Range. — North America, south in winter to South America.
Panama. — Canal Zone and Darien on migration.

Coccyzus erythrophthalmus (Wilson)
Range. — Same as last.
Panama. — Canal Zone and Darien on migration.

Coccyzus minor continentalis van Rossem
Range. — Caribbean coast, Mexico to Panama.
Panama. — Rio Coclé, Caribbean coast.

Coccyzus minor palloris Ridgway
Range. — Pacific coast of Central America.
Panama. — "Chiriqui".

Coccyzus landsbergi Bonaparte
Range. — Northwestern South America.
Panama. — "Panama", in Brit. Mus., fide Sharpe's Hand List.[1]

[1] This locality almost certainly erroneous.

Coccycua rutila panamensis Todd
Range. — Canal Zone and Darien.

Piaya cayana thermophila Sclater
Range. — Most of Central America.
Panama. — Almirante region only.

Piaya cayana incincta Griscom
Range. — Pacific side of western Panama and all of Darien.

Neomorphus salvini salvini Sclater
Range. — Nicaragua to Colombia; rare.
Panama. — Scattered records from the tropical rain forest.

Tapera naevia excellens (Sclater)
Range. — Mexico to west Ecuador.
Panama. — Throughout the Arid Tropical Zone.

Dromococcyx phasianellus rufigularis Lawrence
Range. — Mexico to Paraguay; very rare; the race, Central America.
Panama. — Five records, including all sections.

Crotophaga major Gmelin
Range. — Panama to Paraguay.
Panama. — Darien, chiefly lowland rivers.

Crotophaga ani Linnaeus
Range. — West Indies, South America, and islands off Central American coast.
Panama. — Divalá, Chiriqui (once); Veraguas (once); Canal Zone and Darien.

Crotophaga sulcirostris sulcirostris Swainson
Range. — Texas to western Peru.
Panama. — Western Panama; Canal Zone (Pacific side).

ORDER PSITTACIFORMES

FAMILY PSITTACIDAE — Parrots

Ara ararauna (Linnaeus). Blue and Yellow Macaw
Range. — Panama to Brazil.
Panama. — Rio Chepo, Darien.

Ara chloroptera Gray. Red and Green Macaw
Range. — Same as last.
Panama. — Darien and Canal Zone (where now extinct).

Ara macao (Linnaeus). Scarlet Macaw
Range. — Tropical America.
Panama. — Throughout, in heavy forest only.

Ara ambigua (Bechstein). Green Macaw
Range. — Nicaragua to west Ecuador.
Panama. — Heavy rain forest areas.

Ara severa (Linnaeus). Small Green Macaw
Range. — Panama to Brazil.
Panama. — Canal Zone (formerly) and Darien.

Aratinga finschi (Salvin)
Range. — Nicaragua to western Panama.
Panama. — Coastal forests of western half, both slopes.

Aratinga ocularis (Sclater & Salvin)
Range. — Pacific slope of western Panama to Canal Zone.

Aratinga astec astec (Souancé)
Range. — Mexico to Panama.
Panama. — Almirante region.

Pyrrhura hoffmanni gaudens Bangs
Range. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Bolborhynchus lineola lineola (Cassin)
Range. — Mexico to Panama; rare and local.
Panama. — Volcan de Chiriqui (Caribbean slope).

Brotogerys jugularis jugularis (Muller)
Range. — Mexico to Colombia.
Panama. — Throughout.

Forpus conspicillatus conspicillatus (Lafresnaye)
Range. — Colombia and Darien.
Panama. — Eastern Darien, Rio Tuyra valley,[1] 4 spec. El Real and Tapalisa in A. M. N. H.

Amazona autumnalis salvini (Salvadori)
Range. — Nicaragua to Colombia.
Panama. — Throughout.

[1]Perhaps subspecifically separable; ad. ♂ yellower green, less grayish glaucous green below than Colombian specimens; birds east of the Eastern Andes average smaller than Panama and northwest Colombian birds.

Amazona farinosa virenticeps (Salvadori)
Range. — Nicaragua to western Panama.
Panama. — Chiriqui and Bocas del Toro.

Amazona farinosa inornata (Salvadori)
Range. — Panama to Brazil.
Panama. — Veraguas eastward.

Amazona ochrocephala panamensis (Cabanis)
Range. — Panama and Colombia.
Panama. — Arid Tropical Zone, chiefly Pacific slope.

Pionus menstruus (Linnaeus)
Range. — Costa Rica to Argentina.
Panama. — Throughout.

Pionus senilis decoloratus Griscom
Range. — Costa Rica and Panama.
Panama. — Almirante region only.

Urochroma dilectissima Sclater & Salvin
Range. — Panama to Venezuela; very rare.
Panama. — Summit of Mt. Pirri, Darien.

Eucinetus haematotis haematotis (Sclater & Salvin)
Range. — Mexico to Panama.
Panama. — Western half.

Eucinetus haematotis coccinicollaris (Lawrence)
Range. — Canal Zone and Darien.

Pyrilia pyrilia (Bonaparte)
Range. — Panama to Venezuela.
Panama. — Darien, Rio Tuyra valley, 2 spec., Cituro and Tapalisa, Mar. 17, 1915 (in A. M. N. H.).

ORDER STRIGIFORMES

FAMILY TYTONIDAE — Barn Owls

Tyto perlata guatemalae (Ridgway)
Range. — Central America.
Panama. — Western half to Canal Zone.

FAMILY STRIGIDAE

Rhinoptynx clamator clamator (Vieillot)
Range. — Mexico to Brazil; rare.
Panama. — Known only from Pacific slope, Chiriqui to Canal Zone.

Bubo virginianus mayensis Nelson
Range. — Southern Mexico to western Panama.
Panama. — One record, Chitra, Veraguas[1] (Arcé).

Pulsatrix perspicillata chapmani Griscom
Range. — Western Panama (Caribbean slope) and Darien.

Pulsatrix perspicillata saturata Ridgway
Range. — Mexico to Canal Zone.
Panama. — Western Panama (Pacific slope).

Otus choliba luctisonus Bangs
Range. — Costa Rica to Colombia.
Panama. — Pacific slope, western half and Canal Zone.

Otus guatemalae vermiculatus
Range. — Mts. of Costa Rica to Ecuador; very rare.
Panama. — Subtropical Zone in the mts.; Canal Zone?

Otus nudipes (Vieillot)
Range. — Mts. of Costa Rica and Panama.
Panama. — Subtropical Zone; Calobre, Veraguas; Mt. Pirri, Darien.

Lophostrix cristata stricklandi Sclater & Salvin
Range. — Mexico to Colombia; rare.
Panama. — Heavy forest, almost throughout.

Lophostrix cristata wedeli Griscom
Range. — Caribbean slope, eastern Darien (Permé).

Ciccaba virgata centralis Griscom
Range. — Central America.
Panama. — Western half.

Ciccaba virgata virgata (Cassin)
Range. — Panama to Ecuador.
Panama. — Eastern Darien.

Ciccaba nigrolineata Sclater
Range. — Mexico to west Ecuador; rare.
Panama. — Recorded from Chiriqui, Veraguas and Canal Zone.

[1]Specimen in Brit. Mus. examined.

Speotyto cunicularia hypugaea (Bonaparte)
Range. — Western U. S., south in winter to Panama.
Panama. — Divalá, Chiriqui (once).

Glaucidium brasilianum ridgwayi Sharpe
Range. — Texas to Panama.
Panama. — Pacific slope, east to Canal Zone.

Glaucidium jardini (Bonaparte)
Range. — Temperate Zone, Costa Rica to Peru; rare.
Panama. — Veraguas, the locality, Soná, unquestionably erroneous.

Glaucidium minutissimum rarum Griscom
Range. — Humid tropical forests, Costa Rica and Panama; very rare.
Panama. — Veraguas (Arcé); eastern Darien (3 specimens known).

ORDER CAPRIMULGIFORMES

FAMILY NYCTIBIIDAE — Potoos

Nyctibius grandis (Gmelin)
Range. — Panama to Brazil; rare.
Panama. — Canal Zone and Darien.

Nyctibius griseus costaricensis Ridgway
Range. — Nicaragua to western Panama.
Panama. — Extreme western Chiriqui.

Nyctibius griseus cornutus (Vieillot)[1]
Range. — Panama to Argentina.
Panama. — Veraguas; Canal Zone.

FAMILY CAPRIMULGIDAE — Goatsuckers, Nighthawks

Caprimulgus carolinensis Gmelin
Range. — Southern U. S., in winter to Colombia.
Panama. — Chiriqui (2 records); Permé, Darien, 11/3/29.

Caprimulgus rufus rufus Boddaert
Range. — Costa Rica to Brazil; rare.
Panama. — Chiriqui (once); Veraguas (once); Canal Zone (once); Darien (once).

[1]Includes *panamensis* Ridgway.

Caprimulgus saturatus (Salvin)
Range. — High mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Stenopsis cayannensis albicauda Lawrence
Range. — Costa Rica and Panama; very rare.
Panama. — Five known specimens.

Nyctidromus albicollis intercedens Griscom
Range. — Guatemala to Peru.
Panama. — Common throughout.

Chordeiles minor minor (Forster)
Range. — Eastern N. A., wintering in South America.
Panama. — Probably regular transient; three specimens.

Chordeiles minor sennetti Coues
Range. — Great Plains, wintering probably in South America.
Panama. — Permé, Darien, 10/18/29 (Wedel).

Chordeiles acutipennis texensis Lawrence
Range. — U. S. border and Mexico, in winter to Panama.
Panama. — Canal Zone and Darien in winter.

Chordeiles acutipennis micromeris Oberholser
Range. — Resident in Central America.
Panama. — Veraguas (Arcé); Almirante (Wedel).

ORDER MICROPODIFORMES

FAMILY MICROPODIDAE

Streptoprocne zonaris albicincta (Cabanis)
Range. — Mts. of Costa Rica to Peru.
Panama. — Throughout in the mts.

Chaetura pelagica (Linnaeus)
Range. — Eastern U. S., exact winter quarters unknown.
Panama. — Almirante, 2 records in fall.

Chaetura vauxi richmondi Ridgway
Range. — Guatemala to Panama.
Panama. — Western Chiriqui.

Chaetura chapmani Hellmayr
Range. — Panama to Guiana.
Panama. — Canal Zone, 1 record.

Chaetura spinicauda spinicauda (Boie)
Range. — Panama to Amazonia.
Panama. — Permé, Darien; probably Canal Zone and Pearl Islands also.

Chaetura fumosa Salvin
Range. — Pacific slope, S. W. Costa Rica and Panama.
Panama. — Pacific slope, Volcan de Chiriqui.

Chaetura cinereiventris phæopygos Hellmayr
Range. — Eastern Nicaragua to Panama.
Panama. — Almirante (Wedel, Smith, Benson).

Cypseloides brunneitorques brunneitorques (Lafresnaye)
Range. — Mexico to Peru in the mts.
Panama. — Mts. of Veraguas; to be expected elsewhere.

Panyptila cayannensis (Gmelin)
Range. — Nicaragua to Brazil.
Panama. — Chagres River; Cape Garachiné; recently breeding in Canal Zone.

FAMILY TROCHILIDAE — Hummingbirds

Doryfera ludoriciae veraguensis Salvin
Range. — Mts. of Costa Rica and western Panama; rare.
Panama. — Subtropical Zone, Chiriqui and Veraguas.

Androdon aequatorialis Gould
Range. — Mts. of Panama to Ecuador.
Panama. — Mt. Tacarcuna, 2 spec. at 4600 ft. in A. M. N. H.

Threnetes ruckeri ventosus Bangs and Penard
Range. — Nicaragua to west Panama.
Panama. — Chiriqui and Veraguas, both slopes.

Threnetes ruckeri darienensis Bangs & Barbour
Canal Zone and Darien.

Glaucis hirsuta affinis Lawrence
Range. — Panama to Brazil.
Panama. — Canal Zone to Darien.

Phæthornis guy coruscus Bangs
Range. — Costa Rica to west Colombia.
Panama. — Throughout Pacific slope.

Phæthornis superciliosa cephala (Bourcier & Mulsant)
Range. — Honduras to west Panama.
Panama. — Throughout western half.

Phæthornis superciliosa cassini Lawrence
Range. — Panama and parts of Colombia.
Panama. — Canal Zone eastward.

Phæthornis anthophila hyalina Bangs
Pearl Islands, Bay of Panama.

Phæthornis longuemarea saturata Ridgway
Range. — Guatemala to Panama.
Panama. — Throughout western half.

Phæthornis longuemarea subrufescens Chapman
Range. — Panama to west Ecuador.
Panama. — Canal Zone eastward.

Eutoxeres aquila salvini Gould
Range. — Costa Rica and west Panama; rare.
Panama. — Veraguas.

Eutoxeres aquila munda Griscom
Extreme eastern Darien.

Campylopterus hemileucurus (Lichtenstein)
Range. — Mexico to west Panama, Subtropical Zone.
Panama. — Mts. of western half, very common.

Florisuga mellivora mellivora (Linnaeus)
Range. — Mexico to Bolivia.
Panama. — Throughout humid Tropical Zone.

Phæochroa cuvierii maculicauda Griscom
Range. — Western Costa Rica and Panama.
Panama. — Chiriqui (David & Bugaba).

Phæochroa cuvierii saturatior (Hartert)
Range. — Coiba Island and adjacent coastal forests of Veraguas.

Phæochroa cuvierii cuvierii (Delattre & Bourcier)
Range. — Canal Zone and Darien.

Polyerata amabilis (Gould)
Range. — Nicaragua to Ecuador.
Panama. — Western half (Caribbean slope); Canal Zone and Darien.

Polycrata decora Salvin
Range. — Pacific slope, s. w. Costa Rica and west Panama.
Panama. — Western Chiriqui.

Lepidopyga caeruleogularis caeruleogularis (Gould)
Range. — Pacific slope, western Panama to Canal Zone.

Lepidopyga caeruleogularis confinis Griscom
Range. — Known only from Permé, eastern Darien, where common.

Saucerottia niveoventer (Gould)
Range. — S. w. Costa Rica and western Panama; Talamanca and Almirante?
Panama. — Chiriqui and Veraguas (chiefly above 3000 ft.).

Saucerottia edward edward (Delattre & Bourcier)
Range. — Arid Tropical Zone, from Veraguas and Canal Zone to Rio Chepo.

Saucerottia edward margaritarum Griscom
Range. — Pearl Islands, Bay of Panama.

Saucerottia edward crosbyi Griscom
Range. — Eastern Darien (Capetí and Cape Garachiné).

Goldmania violiceps Nelson[1]
Range. — Darien (Cerro Azul; Rio Tuyra valley).

Goethalsia bella Nelson[1]
Range. — Cana and slopes of Mt. Pirri (2000–5000 ft.); 3 specimens only.

Amazilia tzacatl tzacatl (De La Llave)
Range. — Mexico to Colombia.
Panama. — Common in the Humid Tropical Zone throughout.

Hylocharis eliciae (Bourcier & Mulsant)
Range. — Mexico to Panama.
Panama. — Pacific coastal forests, Chiriqui and Veraguas.

Damophila juliae panamensis Berlepsch
Range. — Pacific slope, western half; Canal Zone; Darien (Cana and Permé).

Chlorostilbon assimilis Lawrence
Range. — S. w. Costa Rica and Panama.
Panama. — Throughout Pacific Slope in Arid Tropical Zone.

[1]Genera which will probably not survive a critical revision of this group by an expert who is not a "splitter."

Panterpe insignis Cabanis & Heine
Range. — High mts. of Costa Rica and Panama.
Panama. — Temperate Zone, mts. of Chiriqui and Veraguas.

Thalurania colombica venusta (Gould)
Range. — Nicaragua to western Panama.
Panama. — Humid coastal forests of western half (both slopes).

Thalurania colombica fannyi (Delattre & Bourcier)
Range. — Panama and western Colombia.
Panama. — Humid Tropical Zone, eastern Darien, both slopes.

Thalurania colombica subtropicalis Griscom
Range. — Subtropical Zone, Darien and western Andes of Colombia.
Panama. — Summit of Mt. Pirri.

Eupherusa egregia Sclater & Salvin
Range. — Mts. of Costa Rica and Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas (Pacific Slope).

Callipharus nigriventris (Lawrence)
Range. — Costa Rica and west Panama.
Panama. — Caribbean slope, mts. of Chiriqui and Veraguas.

Elvira chionura (Gould)
Range. — Mts. of s. w. Costa Rica and Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas (Pacific Slope).

Chalybura buffoni micans Bangs & Barbour
Range. — Canal Zone and Darien.

Chalybura urochrysa isaurae[1] (Gould)
Range. — Caribbean slope of Costa Rica and western Panama; very rare.
Panama. — Definitely Bocas del Toro and Almirante.

Chalybura urochrysa incognita Griscom
Range. — Eastern Darien (both slopes); common.

Colibri delphinae (Lesson)
Range. — Guatemala to Peru.
Panama. — Two records (Pico Calovevora, Veraguas; Cana, Darien).

[1]An occasional specimen strongly approaches *melanorrhoa* Salvin of eastern Nicaragua and Costa Rica.

Colibri cyanotus (Bourcier & Mulsant)
Range. — Mts. of Costa Rica to Bolivia.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas; common.

Anthracothorax nigricollis nigricollis (Vieillot)
Range. — Panama to Paraguay.
Panama. — Canal Zone and Darien.

Anthracothorax veraguensis Reichenbach
Pacific slope of western Panama in the Arid Tropics; rare.

Eugenes spectabilis (Lawrence)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui above 6000 ft.

Orcopyra castancoventris (Gould)
Known only from the Volcan de Chiriqui.

Oreopyra calolaema calolaema Salvin
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Oreopyra cinereicauda Lawrence.
Range. — High mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (above 6000 ft. on Pacific slope).

Oreopyra hemileuca Salvin
Range. — High mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (fide Hartert), presumably Caribbean slope.

Heliodoxa jacula henryi Lawrence
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Heliodoxa jacula jacula Gould
Range. — Mts. of Panama and Colombia.
Panama. — Subtropical Zone, mts. of eastern Darien.

Vestipedes aureliae cauccnsis (Simon)
(including *Eriocnemis floccus* Nelson)
Range. — Mts. of Panama and western Colombia.
Panama. — Subtropical Zone, eastern Darien (Mt. Pirri, Mt. Tacarcuna).

Heliothryx barroti (Bourcier & Mulsant)
Range. — Guatemala to west Ecuador.
Panama. — Throughout the humid Tropical Zone.

Heliomaster longirostris veraguensis (Boucard)
Range. — Costa Rica and west Panama.
Panama. — Western half in open country on Pacific slope.

Heliomaster longirostris stuartae Lawrence
Range. — Panama and Colombia.
Panama. — Obaldia, eastern Darien.

Nesophlox bryantae (Lawrence)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Archilochus colubris (Linnaeus)
Range. — U.S.A., south in winter to Panama.
Panama. — Western Chiriqui (once).

Selasphorus torridus Salvin
Range. — High mts. of Costa Rica and west Panama.
Panama. — Temperate Zone, Volcan de Chiriqui (10,000 ft.).

Selasphorus ardens Salvin
Subtropical Zone, mts. of Chiriqui and Veraguas.

Selasphorus scintilla (Gould)
Range. — High mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Klais guimeti (Bourcier & Mulsant)
Range. — Nicaragua to Peru.
Panama. — In heavy tropical forest, throughout.

Microchera albocoronata[1] (Lawrence)
Caribbean slope of Veraguas, rare and little known.

Lophornis delattrei (Lesson)
Range. — Costa Rica to Colombia.
Panama. — Pacific slope, Veraguas to Darien.

Lophornis adorabilis Salvin
Range. — Costa Rica and west Panama.
Panama. — Western Chiriqui (Pacific slope).

[1]Probably conspecific with *parvirostris* of Costa Rica and Nicaragua.

Popelairia conversii salvini Zeledon
Range. — Costa Rica to Canal Zone.
Panama. — Veraguas and Canal Zone (Caribbean slope).

ORDER TROGONIFORMES

FAMILY TROGONIDAE — Trogons

Pharomacrus mocinno costaricensis Ridgway
Range. — Mts. of Costa Rica and west Panama.
Panama. — Upper Subtropical and Temperate Zone, mts. of Chiriqui and Veraguas.

Pharomacrus auriceps Gould
Range. — Andes of Columbia and Ecuador.
Panama — Mt. Pirri, Darien (fide Chapman).

Trogon collaris puella Gould
Range. — Subtropical Zone, Mexico to west Panama.
Panama. — Mts. of Chiriqui and Veraguas (4000–7000 ft.).

Trogon collaris extimus Griscom
Range. — Subtropical Zone, eastern Darien (Mt. Pirri).

Trogon aurantiiventris aurantiiventris Gould
Range. — Western Costa Rica and west Panama.
Panama. — Subtropical Zone, Volcan de Chiriqui.

Trogon aurantiiventris flavidior Griscom
Subtropical Zone, mts. of eastern Chiriqui Cerro Flores) and Veraguas.

Trogon curucui tenellus Cabanis
Range. — Honduras to Panama.
Panama. — Throughout, in heavy tropical forest.

Trogon violaceus concinnus Lawrence
Range. — Southern Central America.
Panama. — Throughout western half in tropical forest.

Trogon violaceus caligatus Gould
Range. — Panama and northern Colombia.
Panama. — Permé, eastern Darien.

Trogon strigilatus chionurus Sclater & Salvin
Range. — Panama to west Ecuador.
Panama. — Chiriquicito Grande (1 ♂); common, Canal Zone and Darien.

Trogon bairdi Lawrence
Range. — S. w. Costa Rica and west Panama.
Panama. — Lowland forests of western Chiriqui.

Trogon melanurus macrourus Gould
Range. — Panama and northern Colombia.
Panama. — Canal Zone eastward; common.

Trogon massena massena Gould
Range. — Mexico to Panama.
Panama. — Throughout, in heavy tropical forest.

Trogon clathratus Salvin
Range. — Caribbean slope, Costa Rica and west Panama; rare.
Panama. — Veraguas (Arcé); undoubtedly Caribbean slope.

ORDER CORACIIFORMES

FAMILY ALCEDINIDAE — Kingfishers

Megaceryle torquata torquata (Linnaeus)
Range. — Mexico to Bolivia.
Panama. — Common throughout.

Megaceryle alcyon alcyon (Linnaeus)
Range. — North America, south in winter to Colombia.
Panama. — Throughout in winter.

Chloroceryle amazona (Latham)
Range. — Tropical America.
Panama. — Common throughout.

Chloroceryle americana isthmica (Goldman)
Range. — Guatemala to Panama.
Panama. — Abundant throughout.

Chloroceryle inda (Linnaeus)
Range. — Nicaragua to Brazil; rare.
Panama. — Locally throughout in tropical rain forest.

Chloroceryle aenea aenea (Pallas)
Range. — Nicaragua to Brazil; uncommon.
Panama. — Locally, in heavy tropical rain forest.

FAMILY MOMOTIDAE — Motmots

Baryphthengus martii semirufus (Sclater)
Range. — Nicaragua to west Ecuador.
Panama. — Throughout the heavy rain forest areas.

Momotus lessoni lessoni Lesson
Range. — Mexico to west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Momotus subrufescens conexus Thayer & Bangs
Arid Tropical Zone, Pacific slope, Panama City to Cape Garachiné.

Momotus subrufescens reconditus Nelson
Humid Tropical Zone, eastern Darien, both slopes.

Electron platyrhynchum minor (Hartert) [includes *suboles* Nelson].
Range. — Nicaragua to north Colombia.
Panama. — Throughout the forested areas.

Hylomanes momotula obscurus Nelson
Humid Tropical forests of Darien.

FAMILY GALBULIDAE — Jacamars

Jacamerops aurea penardi Bangs & Barbour
Range. — Eastern Costa Rica and Panama.
Panama. — Throughout in humid tropical rain forest.

Galbula melanogenia Sclater
Range. — Mexico to west Ecuador.
Panama. — Western Panama (both slopes); unknown, Canal Zone eastward.

Brachygalba salmoni Sclater & Salvin
Range. — Panama and northern Colombia.
Panama. — Eastern Darien (Rio Jesusito; Cana; Tapalisa and El Real, Tuyra Valley).

FAMILY BUCCONIDAE — Puff-birds

Notharchus hyperrhynchus hyperrhynchus (Sclater)
Range. — Eastern Panama to west Ecuador.
Panama. — Canal Zone eastward.

Notharchus hyperrhynchus dysoni (Sclater)
Range. — Mexico to west Panama.
Panama. — Chiriqui (Pacific slope) and Almirante.

Notharchus pectoralis (Gray)
Range. — Panama to Ecuador.
Panama. — Canal Zone and Darien.

Notharchus tectus subtectus (Sclater)
Range. — Costa Rica to west Ecuador.
Panama. — Veraguas (Caribbean slope); Canal Zone and Darien.

Nystalus radiatus (Sclater)
Range. — Panama to west Ecuador.
Panama. — Veraguas (Caribbean slope); Canal Zone and Darien.

Malacoptila panamensis fuliginosa Richmond
Range. — Nicaragua to western Panama.
Panama. — Almirante region.

Malacoptila panamensis panamensis Lafresnaye
Range. — S. w. Costa Rica to western Colombia.
Panama. — Western Panama (Pacific slope); Canal Zone and Darien.

Micromonacha lanceolata (Deville)
Range. — Eastern Costa Rica to Amazonia; very rare.
Panama. — Rio Calovevora, Veraguas (1 specimen, Benson).

Nonnula frontalis frontalis (Sclater)
Range. — Panama and northern Colombia.
Panama. — Canal Zone and Darien.

Monasa morphœus grandior Sclater & Salvin
Range. — Eastern Nicaragua to western Panama.
Panama. — Almirante region.

Monasa morphœus fidelis Nelson (includes *similis* Nelson)
Known only from eastern Panama (Cerro Azul, 1; Rio Chepo, 2).

Monasa morphœus pallescens Cassin [includes *minor* Nelson].
Range. — Panama and north Colombia.
Panama. — Rio Chiman eastward.

FAMILY CAPITONIDAE — Barbets

Capito maculicoronatus maculicoronatus Lawrence
Veraguas (Caribbean slope) and Canal Zone.

Capito maculicoronatus pirrensis Nelson
Pacific slope of extreme eastern Darien; perhaps adjacent Colombia.

Capito maculicoronatus megas Griscom
Caribbean slope of extreme eastern Darien.

Eubucco bourcieri salvini (Shelley)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Lower Subtropical Zone, mts. of Chiriqui and Veraguas.

Eubucco bourcieri anomalus Griscom
Eastern Darien, in Subtropical Zone (Mt. Pirri).

Dicrorhynchus frantzii (Sclater)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Upper Subtropical Zone, mts. of Chiriqui and Veraguas.

FAMILY RHAMPHASTIDAE — Toucans

Rhamphastos sulphuratus brevicarinatus Gould
Range. — Honduras to Colombia.
Panama. — Common throughout.

Rhamphastos swainsoni Gould
Range. — Honduras to Ecuador.
Panama. — Throughout the tropical rain forest areas.

Rhamphastos abbreviatus Cabanis
Range. — Panama to Ecuador.
Panama. — Canal Zone (1 old record).

Pteroglossus torquatus torquatus (Gmelin)
Range. — Mexico to Panama.
Panama. — Western half (Caribbean slope); Canal Zone and Darien.

Pteroglossus frantzii Cabanis
Range. — S. w. Costa Rica and west Panama.
Panama. — Pacific slope, Chiriqui and Veraguas.

Selenidera spectabilis Cassin
Range. — Nicaragua to Colombia; rare.
Panama. — Heavy tropical rain forest areas.

Aulacorhynchus caeruleogularis maxillaris Griscom
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of western Chiriqui.

Aulacorhynchus caeruleogularis caeruleogularis (Gould)
Mts. of eastern Chiriqui and Veraguas.

Aulacorhynchus caeruleogularis cognatus (Nelson)
Mts. of eastern Darien.

FAMILY PICIDAE — Woodpeckers

Piculus chrysochlorus aurosus (Nelson)
Known only from eastern Darien (1 specimen) and Santa Marta, Colombia.

Piculus callopterus (Lawrence)
Known only from Veraguas (Caribbean slope), Canal Zone and Darien; rare.

Piculus simplex simplex (Salvin) [includes *aurorae* Griscom]
Range.— Nicaragua to Panama; very rare.
Panama. — Chiriqui (Bugaba, 2 spec.); Almirante and Rio Calovevora.

Piculus rubiginosus uropygialis (Cabanis)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Chrysoptilus punctigula lucescens Griscom
Known only from eastern Darien (Cape Garachiné and Cana).

Balanosphyra formicivora striatipectus Ridgway
Range. — Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Centurus rubricapillus wagleri (Salvin & Godman)
Range. — S. w. Costa Rica and Panama.
Panama. — Throughout Pacific slope in Arid Tropical Zone.

Centurus rubricapillus seductus Bangs
Pearl Islands, Bay of Panama.

Centurus pucherani pucherani (Malherbe)
Range. — Nicaragua to Ecuador.
Panama. — Tropical rain forest areas.

Centurus chrysauchen (Salvin)
Range. — S. w. Costa Rica and west Panama.
Panama. — Coastal forests of Chiriqui and Veraguas.

Sphyrapicus varius varius (Linnaeus)
Range. — North America, south to Panama in winter.
Panama. — One record, Cerro Flores, eastern Chiriqui.

Dryobates villosus extimus (Bangs)
Range. — Mts. of Costa Rica and west Panama.
Panama. — High mts. of Chiriqui and Veraguas (above 5000 ft.).

Veniliornis oleaginus saguinolentus (Sclater)
Range. — Mexico to west Panama.
Panama. — Chiriqui and Veraguas, chiefly in the mts.

Veniliornis oleaginus subsp. (*aureus* Chapman?)
Known only from Mt. Tacarcuna (3 spec. in A. M. N. H.).

Veniliornis kirkii neglectus Bangs
Range. — S. w. Costa Rica and west Panama; rare.
Panama. — Pacific slope, western Chiriqui.

Veniliornis kirkii cecilii (Malherbe) [includes *darienensis* Ridgw.]
Range. — East Panama to west Ecuador.
Panama. — Extreme eastern Darien, both coasts; common.

Celeus castaneus (Wagler)
Range. — Mexico to Panama.
Panama. — Almirante Region.

Celeus loricatus diversus Ridgway
Range. — East Costa Rica and west Panama; rare.
Panama. — Almirante region.

Celeus loricatus mentalis Cassin
Range. — Canal Zone and Darien to n. w. Colombia; common.

Celeus immaculatus Berlepsch
The unique type doubtfully from Agua Dulce, Panama.[1]

[1]A region of extremely arid plains. The genus *Celeus* is confined to humid tropical forests. The present species is closely related to the South American *elegans*.

Phlœocastes melanoleucus malherbii (Gray)
Range. — Panama to Venezuela.
Panama. — Throughout the heavy forest areas.

Phlœocastes guatimalensis guatimalensis (Hartlaub)
Range. — Mexico to west Panama.
Panama. — Extreme west (Almirante and Chiriqui).

Phlœocastes splendens (Hargitt)
Range. — Panama to Ecuador.
Panama. — Heavy rain forest areas.

Ceophlœus lineatus mesorhynchus Cabanis & Heine
Range. — Costa Rica and west Panama.
Panama. — Western half.

Ceophlœus lineatus nuperus Peters
Range. — Canal Zone, Darien, and Colombia.

Picumnus olivaceus flavotinctus Ridgway [includes *panamensis* Ridgway]
Range. — S. w. Costa Rica and Panama.
Panama. — Pacific coast in Arid Tropics east to Rio Chepo.

Picumnus olivaceus olivaceus Lafresnaye
Range. — Panama and Colombia.
Panama. — Extreme eastern Darien.

ORDER PASSERIFORMES

FAMILY RHINOCRYPTIDAE — Tapaculos

Scytalopus argentifrons Ridgway[1]
Mts. of Costa Rica and Chiriqui.
Panama. — Volcan de Chiriqui.

Scytalopus chiriquensis Griscom
Eastern Chiriqui (Cerro Flores) and mts. of Veraguas.

Scytalopus panamensis Chapman
Mt. Tacarcuna, eastern Darien.

[1]All three "species" are probably races of some Andean species. The group badly needs revision.

FAMILY FORMICARIIDAE — Ant-birds

Cymbilaimus lineatus fasciatus (Ridgway)
Range. — Nicaragua to west Ecuador.
Panama. — Throughout rain forest areas.

Taraba major melanocrissus (Sclater)
Range. — Mexico to western Panama (Caribbean slope).
Panama. — Almirante region only.

Taraba major transandeana (Sclater)
Range. — Panama to west Ecuador.
Panama. — Almost throughout in heavy forest.

Thamnophilus doliatus nigricristatus Lawrence
Canal Zone, Darien and adjacent Colombia.

Thamnophilus doliatus intermedius Ridgway
Range. — Central America.
Panama. — Western half.

Thamnophilus nigriceps Sclater
Range. — Panama and northern Colombia.
Panama. — Eastern Darien (drier areas of Pacific slope).

Thamnophilus bridgesi Sclater
S. w. Costa Rica and west Panama.
Panama. — Pacific slope, coastal forests of Chiriqui and Veraguas.

Thamnophilus punctatus atrinucha Salvin & Godman
Range. — Honduras to west Ecuador.
Panama. — Heavy forest throughout.

Thamnistes anabatinus saturatus Ridgway
Range. — Costa Rica and western Panama; uncommon.
Panama. — Heavy forest of extreme western part, both slopes.

Thamnistes anabatinus coronatus Nelson
Range. — Interior of Veraguas; Canal Zone and Darien.

Dysithamnus mentalis septentrionalis Ridgway
Range. — Guatemala to Panama.
Panama. — Western half.

Dysithamnus mentalis suffusus Nelson
Eastern Darien and northern Colombia.

Dysithamnus puncticeps puncticeps Salvin
Caribbean lowlands of Panama, Almirante to Obaldia and adjacent Colombia.[1]

Dysithamnus puncticeps intcusus Griscom
Pacific slope of eastern Darien and western Colombia.

Myrmotherula brachyura ignota Griscom
Canal Zone and Pacific slope of eastern Darien.

Myrmotherula surinamensis pacifica Hellmayr
Range. — Panama to west Ecuador.
Panama. — Almirante (once), throughout humid tropics of eastern Panama.

Myrmotherula fulviventris Lawrence
Range. — Honduras to west Ecuador.
Panama. — Tropical Zone, throughout humid sections.

Myrmotherula axillaris albigula Lawrence
Range. — Honduras to west Ecuador.
Panama. — Throughout humid tropics.

Myrmotherula schisticolor schisticolor (Lawrence)
Range. — Guatemala to west Ecuador.
Panama. — Throughout.

Herpsilochmus rufimarginatus exiguus Nelson
Pacific slope of eastern Darien; only twice collected.

Microrhopias boucardi virgata (Lawrence)
Range. — Nicaragua to Canal Zone.
Panama. — Western half.

Microrhopias boucardi consobrina (Sclater)
Range. — Panama to west Ecuador.
Panama. — Eastern half.

Neorhopias grisea alticincta (Bangs)
Pearl Islands, Bay of Panama.

Terenura callinota (Sclater)
Range. — Panama to western Ecuador; very rare.
Panama. — Calobre, Veraguas (1 spec. 1870).[2]

[1]Also in extreme southeastern Costa Rica.

[2]Specimen in Brit. Mus. examined; rump paler rufous, with less black tipping to back than South American specimens, but more material is needed.

Cercomacra tyrannina crepera Bangs
Range. — Mexico to west Panama.
Panama. — Western half.

Cercomacra tyrannina rufiventris (Lawrence)
Range. — Panama to west Ecuador.
Panama. — Canal Zone eastward.

Cercomacra nigricans Sclater
Range. — Panama to west Ecuador; very common.
Panama. — Arid tropics Pacific slope, Veraguas eastward; Pearl Islands.

Gymnocichla nudiceps erratilis Bangs
Range. — S. w. Costa Rica and west Panama (Pacific slope).
Panama. — Chiriqui and Veraguas, heavy forest, base of mountains.

Gymnocichla nudiceps nudiceps (Cassin)
Humid tropics, eastern Panama and adjacent Colombia.

Myrmeciza longipes panamensis Ridgway
Eastern Panama and northern Colombia (chiefly arid tropics).

Myrmeciza laemosticta laemosticta Salvin
Range. — Caribbean slope, Costa Rica and west Panama; rare.
Panama. — Almirante and Veraguas.

Myrmeciza laemosticta palliata Todd
Eastern Panama and adjacent Colombia; not uncommon.

Myrmeciza exsul occidentalis Cherrie
Pacific slope, s. w. Costa Rica and west Panama.
Panama. — Coastal forests, Chiriqui, Veraguas, and Rio Chepo, Darien; very common.

Myrmeciza exsul exsul Sclater
Range. — Nicaragua to eastern Panama.
Panama. — Whole Caribbean slope and Rio Chiman, Pacific slope.

Myrmeciza maculifer cassini (Ridgway)
Pacific slope extreme eastern Darien and adjacent Colombia.

Myrmeciza immaculata zeledoni Ridgway
Range. — Pacific slope, s. w. Costa Rica and west Panama.
Panama. — Chiriqui and Veraguas, in arid scrub and gallery forest; rare.

Myrmeciza immaculata berlepschi Ridgway
Range. — East Panama to west Ecuador.
Panama. — Pacific slope, eastern Darien, in arid tropics.

Xenornis setifrons Chapman
Eastern Darien, 3 known specimens.

Formicarius analis umbrosus Ridgway
Caribbean lowlands, Nicaragua to Panama; uncommon.
Panama. — Almirante region.

Formicarius analis hoffmanni (Cabanis)
Range. — S. w. Costa Rica and west Panama; uncommon.
Panama. — Pacific slope, Chiriqui (western half only).

Formicarius analis panamensis Ridgway
Canal Zone and Darien; very common.

Formicarius nigricapillus nigricapillus Ridgway
Range. — Costa Rica and west Panama; very rare.
Panama. — Chiriqui Lagoon and Veraguas.

Formicarius rufipectus rufipectus Salvin
Range. — Costa Rica and west Panama; very rare.
Panama. — Chiriqui (once); Veraguas (once).

Formicarius rufipectus carrikeri Chapman[1]
Range. — Panama to west Ecuador.
Panama. — Eastern Darien (once).

Gymnopithys bicolor olivascens (Ridgway)
Range. — Honduras to west Panama.
Panama. — Western Chiriqui and Bocas del Toro.

Gymnopithys bicolor bicolor (Lawrence)
Range. — Balance of Panama and adjacent Colombia.

Hylophylax nævioides capnitis (Bangs)
Range. — Caribbean lowlands, Nicaragua to west Panama.
Panama. — Chiriqui Lagoon and Rio Calovevora.

Hylophylax nævioides nævioides (Lafresnaye)
Range. — Panama to west Ecuador.
Panama. — Canal Zone and Darien.

[1]Referred to typical *rufipectus* by Zimmer (Amer. Mus. Novit., no. 584, 1932, p. 9).

Phaenostictus mcleannani saturatus (Richmond)
Range. — Caribbean lowlands, Nicaragua to west Panama.
Panama. — Almirante region.

Phaenostictus mcleannani mcleannani (Lawrence)
Veraguas (Rio Calovevora) and Canal Zone.

Phaenostictus mcleannani chocoanus Bangs & Barbour
Extreme eastern Darien (both slopes) and adjacent Colombia.

Myrmornis stictoptera (Salvin)
Eastern Nicaragua and eastern Darien (both slopes).

Pittasoma michleri zeledoni Ridgway
Eastern Costa Rica and west Panama (Almirante); rare.

Pittasoma michleri michleri Cassin
Veraguas, Canal Zone, Darien and adjacent Colombia; uncommon.

Grallaricula flavirostris costaricensis Lawrence
Range. — Mts. of Costa Rica and west Panama; rare.
Panama. — Mts. of Chiriqui and Veraguas (3 collections).

Grallaricula flavirostris brevis Nelson
Mt. Pirri (5000 ft.), eastern Darien.

Grallaria guatimalensis princeps Sclater & Salvin
Range. — Mts. of Costa Rica and west Panama; rare.
Panama. — Mts. of Chiriqui and Veraguas.

Grallaria guatimalensis chocoensis Chapman
Eastern Darien (Cana, Mt. Pirri, 1 spec.) and Baudo Mts., Choco, Colombia (1 spec.).

Grallaria fulviventris flammulatus (Griscom)
Almirante, west Panama (2 specs.).

Grallaria fulviventris barbacoae (Chapman)
Range. — Eastern Panama and western Colombia.
Panama. — Eastern Darien, Pacific slope (Cana, Tacarcuna).

Grallaria perspicillata intermedia Ridgway
Range. — Caribbean slope, Nicaragua to west Panama.
Panama. — Chiriqui Lagoon.

Grallaria perspicillata perspicillata Lawrence
Central and eastern Panama (throughout) and adjacent Colombia.

FAMILY FURNARIIDAE — Oven-Birds, etc.

Lochmias nematura sororia Sclater and Salvin
Range. — Andes of Ecuador, Colombia and Venezuela.
Panama. — Mt. Pirri, Darien (fide Chapman.)

Synallaxis albescens hypoleuca Ridgway
Pacific slope of Panama in arid tropics, Chiriqui to Rio Chepo.

Synallaxis braehyura nigrifumosa Lawrence
Range. — Caribbean slope, Nicaragua to west Panama.
Panama. — Definitely only from Almirante.

Synallaxis braehyura ehapmani Bangs & Penard
Range. — East Panama to west Colombia.
Panama. — Darien (Pacific slope only).

Cranioleuca erythrops rufigenis (Lawrence)
Range. — Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (7500–10,000 ft.).

Cranioleuca erythrops griseigularis (Ridgway)
Range. — Mts. of eastern Panama and W. Colombia.
Panama. — Mt. Pirri, Darien (fide Chapman.)

Xenerpestes minlosi Berlepsch
Range. — Darien and Colombia; very rare, 7 known specimens.
Panama. — Eastern Darien (Tacarcuna, Rio Sambu).

Margarornis bellulus Nelson
Eastern Darien, Mt. Pirri.

Margarornis rubiginosa rubiginosa Lawrence
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Margarornis rubiginosa boultoni Griscom
Mts. of eastern Chiriqui and Veraguas.

Premnoplex brunneseens brunneicauda Lawrence
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui.

Premnoplex brunneseens distinctus Griscom
Mts. of Veraguas.

Premnoplex brunneseens albescens Griscom
Mt. Tacarcuna, Darien.

Pseudocolaptes boissonneautii lawrencii Ridgway
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Pseudocolaptes boissonneautii panamensis Griscom
Mts. of eastern Chiriqui and Veraguas.

Hyloctistes subulatus assimilis (Berlepsch & Taczanowski)
Eastern Panama to west Ecuador.
Panama. — Tropical rain forest, eastern Darien.

Hyloctistes subulatus virgatus (Lawrence)
Costa Rica and west Panama.
Panama. — Western half (rare).

Xenoctistes subalaris lineatus (Lawrence)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Xenoctistes subalaris tacarcunae (Chapman)
Mts. of eastern Darien (Mt. Pirri, Mt. Tacarcuna).

Xenicopsoides montanus variegaticeps (Sclater)
Mts. of Mexico to Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Philydor fuscipennis fuscipennis Salvin
Only known from Veraguas; very rare.

Philydor fuscipennis erythronotus Sclater & Salvin
Eastern Panama to west Ecuador.
Panama. — Eastern Darien in tropical rain forest.

Philydor rufus rufescens (Lawrence) [= *panerythrus auct.*]
Mts. of Costa Rica and west Panama; rare.
Panama. — Volcan de Chiriqui; "Veragua."

Automolus rubiginosus fumosus[1] Salvin & Godman
Subtropical Zone, Volcan de Chiriqui; very rare, 4 specimens only.

Automolus ochrolaemus hypophaeus Ridgway
Caribbean slope of Costa Rica and west Panama; uncommon.
Panama. — Almirante.

[1]The recently described *A. xanthippe* Davison from Barriles, Chiriqui, probably belongs here; I have seen the type, and also the type of *fumosus* in Brit. Mus., but direct comparison was impossible.

Automolus ochrolaemus exsertus Bangs
Pacific slope of Costa Rica and west Panama; uncommon.
Panama. — Chiriqui and Veraguas.

Automolus ochrolaemus pallidigularis Lawrence
Panama to west Ecuador.
Panama. — Canal Zone eastward throughout; very common.

Automolus nigricauda saturatus Chapman
Eastern Panama and adjacent Colombia.

Thripadectes rufobrunneus (Lawrence)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui.

Xenops minutus ridgwayi Hartert & Goodson
Nicaragua to Panama.
Panama. — Western half.

Xenops minutus littoralis Sclater
Panama to west Ecuador.
Panama. — Darien.

Xenops rutilus septentrionalis Zimmer
Costa Rica and west Panama; very rare.
Panama. — Volcan de Chiriqui.

Xenops rutilus heterurus Cabanis & Heine
Panama to west Ecuador and Trinidad.
Panama. — Eastern Darien (Cana).

Sclerurus albigularis canigularis Ridgway
Costa Rica and west Panama.
Panama. — Chiriqui (Pacific slope).

Sclerurus mexicanus pullus Bangs
Caribbean slope of western Panama, and Mt. Tacarcuna, Darien, chiefly at higher altitudes; rare.

Sclerurus mexicanus andinus Chapman (*anomalus* Bangs & Barbour)
Eastern Panama and parts of Colombia.
Panama. — Darien (both slopes, in the lowlands).

Sclerurus guatemalensis guatemalensis (Hartlaub)
Mexico to Panama.
Panama. — Throughout in tropical rain forest.

Selerurus guatemalensis salvini Salvadori & Festa
Panama to west Ecuador.
Panama. — Eastern Darien (arid tropical zone, Cape Garachiné).

FAMILY DENDROCOLAPTIDAE — Woodhewers

Dendrocolaptes certhia sancti-thomae (Lafresnaye) [including *hesperius* Bangs]
S. Mexico to Colombia.
Panama. — Throughout.

Dendrocolaptes picumnus costaricensis Ridgway
Costa Rica and west Panama; very rare.
Panama. — Volcan de Chiriqui (1 ♀, Boquete).

Dendrocolaptes picumnus veraguensis Griscom
Veraguas (mts. near Chitrá).

Xiphocolaptes promeropirhynchus panamensis Griscom
Mts. of eastern Veraguas; very rare.

Dendroplex picirostris extimus Griscom
Pacific slope of Panama (Agua Dulce, Canal Zone, Garachiné).

Xiphorhynchus guttatus costaricensis (Ridgway)
Nicaragua to west Panama.
Panama. — Extreme west (Almirante, David).

Xiphorhynchus guttatus marginatus Griscom
Veraguas (Pacific coast forests).

Xiphorhynchus guttatus nanus (Lawrence)
Panama (balance of country) and adjacent Colombia.

Xiphorhynchus lachrymosus lachrymosus (Lawrence) [includes *eximius* Hellmayr]
Nicaragua to west Ecuador.
Panama. — Tropical rain forests throughout.

Xiphorhynchus erythropygius punctigulus (Ridgway)
Nicaragua to west Panama.
Panama. — Western half in tropical rain forests.

Xiphorhynchus erythropygius insolitus Ridgway
Eastern Panama and adjacent Colombia.

Lepidocolaptes affinis neglectus (Ridgway)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Lepidocolaptes souleyetii compressus (Cabanis)
Nicaragua to west Panama.
Panama. — Caribbean slope (Almirante), Pacific slope (Chiriqui and Veraguas).

Lepidocolaptes souleyetii lineaticeps (Lafresnaye)
Panama to Venezuela.
Panama. — Canal Zone and Darien.

Campylorhamphus trochilirostris brevipennis Griscom
Canal Zone and Darien; uncommon.

Campylorhamphus pusillus borealis (Carriker)
Costa Rica and west Panama; rare.
Panama. — Western Chiriqui (3 records).

Campylorhamphus pusillus olivaceus Griscom
Veraguas (Rio Calovevora and Chitra).

Glyphorhynchus spirurus sublestus Peters
Costa Rica to west Ecuador.
Panama. — Throughout.

Sittasomus griseicapillus levis Bangs
Panama and Colombia.
Panama. — Pacific slope only, Chiriqui and Veraguas.

Deconychura longicauda typica Cherrie
Pacific slope, Costa Rica and Panama; rare.
Panama. — Recorded only from western Chiriqui.

Deconychura longicauda darienensis Griscom
Darien (Cana, 1; Rio Chepo, 3).

Dendrocincla meruloides ridgwayi Oberholser
Honduras to west Ecuador.
Panama. — Almost throughout; rare in western half and unknown from Chiriqui (Pacific slope).

Dendrocincla homochroa accdesta Oberholser
Pacific slope, Nicaragua to Panama.
Panama. — Chiriqui (lower slopes of mts. only).

Dendrocincla homochroa ruficeps Sclater & Salvin
Pacific slope, Veraguas, Canal Zone and Darien.

Dendrocincla anabatina saturata Carriker
Costa Rica and west Panama, Pacific slope.
Panama. — Coastal forests of western Chiriqui.

FAMILY OXYRUNCIDAE — Sharp-Bills

Oxyruncus cristatus frater (Sclater & Salvin)
Mts. of Costa Rica and west Panama; rare.
Panama. — Recorded only from the mts. of Veraguas.

Oxyruncus cristatus brooksi Bangs & Barbour
Eastern Darien (Mt. Sapo, Tacarcuna, Cana).

FAMILY PIPRIDAE — Manakins

Pipra coronata velutina Berlepsch
Western half of Panama and adjacent Costa Rica.

Pipra coronata minuscula Todd
Panama to west Ecuador.
Panama. — Canal Zone and Darien.

Pipra mentalis ignifera Bangs
Costa Rica and Panama.
Panama. — Western half.

Pipra mentalis minor Hartert
Panama to west Ecuador.
Panama. — Canal Zone and Darien (where rare).

Pipra erythrocephala erythrocephala (Linnaeus)
Panama to Guiana and Brazil.
Panama. — Darien (Rio Chepo eastward, abundant).

Pipra pipra anthracina Ridgway
Costa Rica and west Panama; rare.
Panama. — Pacific slope, Chiriqui and Veraguas.

Chloropipo holochlora suffusa Griscom
Eastern Darien (both slopes).

Chiroxiphia lanceolata (Wagler)
Panama to Venezuela.
Panama. — Pacific slope, throughout Arid Tropical Zone.

Corapipo altera altera Hellmayr
Nicaragua to Colombia.
Panama. — Humid Tropical Zone, whole Caribbean slope and Pacific slope, Veraguas eastward.

Corapipo altera heteroleuca Hellmayr
S. w. Costa Rica and west Panama.
Panama. — Pacific slope, western Chiriqui.

Manacus cerritus Peters
Panama. — Endemic in the Almirante region.

Manacus aurantiacus (Salvin)
Pacific slope, Costa Rica and west Panama.
Panama. — Lowlands of Chiriqui and Veraguas.

Manacus vitellinus vitellinus (Gould)
Panama. — Caribbean slope (Cricamola eastward), Canal Zone and most of Darien.

Manacus vitellinus viridiventris Griscom
Pacific slope, extreme eastern Darien (Cana) and west Colombia.

Schiffornis turdinus verae-pacis (Sclater & Salvin)
Mexico to west Panama.
Panama. — Pacific slope only, coastal forests of Chiriqui and Veraguas.

Schiffornis turdinus furvus (Ridgway)
Upper tropical zone, interior of Veraguas and Mt. Tacarcuna.

Schiffornis turdinus panamensis Hellmayr
Coastal forests of Darien (Canal Zone eastward).

Sapayoa aenigma Hartert
Panama to west Ecuador.
Panama. — Extreme eastern Darien (both coasts).

FAMILY COTINGIDAE — Chatterers, Becards, etc.

Cotinga ridgwayi Ridgway
S. w. Costa Rica and west Panama; very rare.
Panama. — Western Chiriqui (Bugaba, 4 specimens in all).

Cotinga nattereri (Boissonneau)
Panama to Ecuador.
Panama. — Canal Zone and Darien; common.

Carpodectes nitidus Salvin
Honduras to Panama, Caribbean slope.
Panama. — Almirante Bay (Benson; Kennard)

Carpodectes antoniae Ridgway
Pacific slope, s. w. Costa Rica and Panama; very rare.
Panama. — Chiriqui, Pedregal, 2♂.

Attila spadiceus citreopygus (Bonaparte)
Nicaragua to Panama.
Panama. — Western half.

Attila spadiceus sclateri Lawrence
Canal Zone, Darien and adjacent Colombia.

Laniocera rufescens rufescens (Sclater)
Guatemala to Colombia; very rare northward.
Panama. — Throughout, but only 3 records outside of Darien.

Rhytipterna holerythra holerythra (Sclater & Salvin)
Guatemala to Colombia.
Panama. — Throughout in heavy tropical forest areas.

Lipaugus unirufus unirufus Sclater
Mexico to Panama.
Panama. — Throughout western half.

Lipaugus unirufus castaneotinctus (Hartert)
Panama to west Ecuador.
Panama. — Canal Zone eastward.

Pachyramphus versicolor costaricensis Bangs
Mts. of Costa Rica and west Panama; rare.
Panama. — Volcan de Chiriqui (Boquete, 1 spec. Batty, in A. M. N. H.).

Pachyramphus cinnamomeus cinnamomeus Lawrence
Panama to west Ecuador.
Panama. — Almost throughout, but unrecorded from Pacific slope of Chiriqui.

Pachyramphus polychropterus cinereiventris Sclater
Guatemala to Colombia.
Panama. — Common throughout.

Pachyramphus rufus (Boddaert)
Panama to Brazil.
Panama. — Canal Zone and Rio Chepo, 3 records only.

Pachyramphus albogriseus ornatus Cherrie
Nicaragua to Panama; very rare.
Panama. — Pacific slope of Chiriqui and Veraguas.

Pachyramphus albogriseus subsp.[1]
Panama to west Ecuador.
Panama. — Pacific slope of Darien (Rio Chepo and Punta de Sabana).

Platypsaris homochrous homochrous (Sclater)
Panama to west Ecuador.
Panama. — Canal Zone and Rio Chepo.

Tityra semifasciata costaricensis Ridgway
Honduras to Panama.
Panama. — Throughout western half and most of Darien.

Tityra semifasciata columbiana Ridgway
Panama to Venezuela.
Panama. — Eastern Darien (both coasts).

Tityra inquisitor fraserii (Kaup)
Mexico to west Panama.
Panama. — Throughout western half; rare.

Tityra inquisitor albitorques Dubus
Panama to Peru.
Panama. — Eastern Darien.

Querula purpurata (Muller)
Costa Rica to Brazil.
Panama. — Western half (Caribbean slope only), Canal Zone and Darien.

Cephalopterus glabricollis Gould
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas; rare.

Procnias tricarunculata (J. & E. Verreaux)
Mts. of Nicaragua to west Panama.
Panama. — Mts. of Chiriqui and Veraguas; common.

[1]Not *salvini* Richmond, fide Hellmayr.

FAMILY TYRANNIDAE — Tyrant Flycatchers

Sayornis nigricans amnicola Bangs
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Sayornis nigricans latirostris (Cabanis & Heine)
Mts. of Panama to Bolivia.
Panama. — Mt. Tacarcuna.

Colonia colonus leuconota (Lafresnaye)
Honduras to west Ecuador.
Panama. — Throughout tropical rain forest areas.

Fluvicola pica pica (Boddaert)
Panama to Brazil.
Panama. — Tapia River marshes (Chapin & Rogers)

Muscivora forficata (Gmelin)
S. w. United States, south in winter to Panama.
Panama. — Chiriqui (David & Divalá).

Muscivora tyrannus (Linnaeus)
Throughout the Neotropical Region.
Panama. — Throughout the Arid Tropical Zone on the Pacific Slope.

Tyrannus tyrannus (Linnaeus)
Eastern North America, wintering in South America.
Panama. — Common transient, chiefly on Caribbean slope.

Tyrannus melancholicus chloronotus Berlepsch
Mexico to Colombia.
Panama. — Throughout.

Tyrannus dominicensis dominicensis (Gmelin)
West Indies and Cozumel Island, to South America in winter.
Panama. — Winter resident, Canal Zone and Caribbean coast of Darien.

Legatus leucophaius leucophaius (Vieillot)
Nicaragua to Argentina.
Panama. — Local, chiefly in Arid Tropical Zone or clearings elsewhere.

Sirystes sibilator albogriseus (Lawrence)
Panama. — Veraguas, Canal Zone, Darien; very rare, 6 known specimens.

Myiodynastes luteiventris Sclater
U. S. and northern Central America, to South America in winter.
Panama. — A transient only, seldom recorded.

Myiodynastes maculatus nobilis Sclater
Costa Rica to Peru.
Panama. — Throughout Arid Tropical Zone, in clearings elsewhere.

Myiodynastes hemichrysus (Cabanis)
Mts. of Costa Rica and west Panama; very rare.
Panama. — Mts. of Chiriqui and Veraguas.

Megarhynchus pitangua mexicanus (Lafresnaye)
Mexico to Panama.
Panama. — Almost throughout.

Megarhynchus pitangua pitangua (Linnaeus)
Panama to Argentina.
Panama. — Extreme eastern Darien (Obaldia).

Coryphotriccus parvus albovittatus (Lawrence)
Panama to Ecuador; very rare.
Panama. — Canal Zone; Rio Chepo, 1♂ (Havemeyer coll.).

Myiozetetes cayanensis harterti Bangs & Penard
Canal Zone and Darien.

Myiozetetes similis columbianus Cabanis & Heine
Costa Rica to Venezuela.
Panama. — Throughout Arid Tropics, in clearings elsewhere.

Myiozetetes granadensis granadensis Lawrence
Nicaragua to Peru.
Panama. — Throughout humid tropical forest areas.

Pitangus sulphuratus guatimalensis (Lafresnaye)
Guatemala to Panama.
Panama. — Almirante region.

Pitangus lictor panamensis Bangs & Penard
Canal Zone, Darien and adjacent Colombia.

Myiarchus crinitus boreus Bangs
Eastern U. S., in winter to Colombia.
Panama. — Throughout in winter.

Myiarchus ferox panamensis Lawrence
Panama to Venezuela.
Panama. — Pacific slope only of western half, in clearings or open country elsewhere.

Myiarchus tuberculifer nigricapillus Cabanis [includes *bangsi* Nelson]
Costa Rica and western Panama.
Panama. — Western half, chiefly in heavy forest.

Myiarchus tuberculifer brunneiceps Lawrence
Canal Zone and Darien, chiefly heavy forest.

Nuttallornis borealis cooperi (Nuttall)
E. North America, wintering in South America.
Panama. — Throughout on migration.

Nuttallornis borealis borealis (Swainson)
W. North America, wintering in South America.
Panama. — On migration.

Myiochanes virens (Linnaeus)
Eastern North Amer., wintering in South America.
Panama. — Throughout on migration.

Myiochanes richardsonii richardsonii (Swainson)
Western N. A., wintering in South America.
Panama. — Numerous records on migration.

Myiochanes richardsonii sordidulus (Sclater)
Mts. of Mexico and Central America.
Panama. — Mts. of Chiriqui and Veraguas (breeding).

Myiochanes brachytarsus brachytarsus (Sclater)
Mexico to Panama.
Panama. — Pacific slope, Chiriqui to Rio Chepo, Darien.

Myiochanes lugubris (Lawrence)
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui, chiefly Temperate Zone.

Empidonax flavirentris (Baird)
Eastern North America, south in winter to Panama.
Panama. — Winter visitant, quite common western half, Darien (once).

Empidonax virescens (Vieillot)
Eastern U. S., in winter to South America.
Panama. — On migration, Caribbean slope only.

Empidonax traillii traillii (Audubon)
Eastern N. A., south in winter to South America.
Panama. — Recorded from Taboga Isl., Canal Zone and Almirante on migration.

Empidonax traillii brewsteri Oberholser
Western N. A., wintering from Guatemala to Bolivia.
Panama. — On migration; 1 mid-winter record Almirante.

Empidonax minimus (Baird)
Eastern U. S., south in winter to Panama.
Panama. — Chiriqui (once); Canal Zone (once).

Empidonax flavescens flavescens Lawrence
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui, Subtropical Zone.

Empidonax flavescens floresae Griscom
Cerro Flores, eastern Chiriqui.

Empidonax flavescens chitrae Griscom
Mts. of eastern Veraguas.

Empidonax albigularis australis Miller and Griscom
Vera Cruz to Panama, Caribbean slope; rare.
Panama. — Chiriquicito (1 spec.); Canal Zone (1 old record?)

Empidonax atriceps Salvin
High mts. of Costa Rica and Panama.
Panama. — Temperate Zone, Volcan de Chiriqui.

Mitrophanes aurantiiventris aurantiiventris (Lawrence)
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Mitrephanes aurantiiventris viridus Griscom
Mts. of Veraguas.

Mitrephanes berlepschi eminulus Nelson
Mts. of eastern Darien.

Terenotriccus erythrurus fulvigularis (Salvin & Godman)
Guatemala to west Ecuador.
Panama. — Throughout forested areas.

Aphanotriccus audax (Nelson)
Darien (Rio Chepo, 3 spec.; Cana, Mt. Pirri).

Myiobius sulphureipygius aureatus Bangs
Honduras to west Ecuador.
Panama. — Absent only from the arid tropics of the Pacific Coast.

Myiobius atricaudus atricaudus Lawrence
Costa Rica to Colombia.
Panama.—Recorded throughout the Pacific slope and at Almirante.

Myiophobus fasciatus furfurosus (Thayer & Bangs)
Arid Tropical Zone, Pacific slope, Costa Rica and Panama.
Panama. — Savannas of Veraguas to Rio Chepo, Darien and Pearl Islands.

Onychorhynchus coronatus mexicanus (Sclater)
Mexico to west Panama.
Panama. — Western half in heavy forest.

Onychorhynchus coronatus fraterculus Bangs
Panama and northern Colombia.
Panama. — Canal Zone and Darien.

Platyrinchus mystaceus neglectus (Todd)
Costa Rica to Colombia.
Panama. — Pacific slope of Chiriqui and Veraguas.

Platyrinchus coronatus superciliaris Lawrence
Nicaragua to west Ecuador.
Panama. — Throughout tropical rain forest areas.

Cnipodectes subbrunneus subbrunneus (Sclater)
Panama to west Ecuador.
Panama. — Canal Zone and Darien, rain forest areas.

Tolmomyias sulphurescens flavo-olivaceus (Lawrence)
Pacific slope, Chiriqui to Rio Chepo, Darien; little known.

Tolmomyias flavotectus (Hartert)
Costa Rica to west Ecuador, uncommon to rare northward.
Panama. — Humid tropical forests.

Rhynchocyclus olivaceus bardus (Bangs & Barbour)
Canal Zone and Darien.

Rhynchocyclus brevirostris brevirostris (Cabanis)
Mexico to Panama.
Panama. — Pacific slope, Chiriqui and Veraguas, in heavy forest.

Rhynchocyclus brevirostris hellmayri Griscom
Eastern Darien (Mt. Pirri, Mt. Tacarcuna).

Todirostrum nigriceps Sclater
Costa Rica to west Ecuador; rare.
Panama. — Almirante and Canal Zone.

Todirostrum cinereum finitimum Bangs
Mexico to Panama.
Panama. — Western half and Canal Zone.

Todirostrum sylvia schistaceiceps Sclater
Mexico to Panama.
Panama. — Western half and Canal Zone.

Oncostoma cinereigulare (Sclater)
Mexico to Panama.
Panama. — Chiriqui (Bogaba) and Almirante.

Oncostoma olivaceum (Lawrence)
Canal Zone (rare), Darien (common) and adjacent Colombia.

Lophotriccus pileatus luteiventris Taczanowski
Mts. of Costa Rica and West Panama.
Panama. — Subtropical Zone. mts. of Chiriqui and Veraguas.

Lophotriccus pileatus squamaecrista (Lafresnaye)
Panama to Ecuador and Venezuela.
Panama. — Eastern Darien (Mt. Pirri).

Atalotriccus pilaris wilcoxi Griscom
Pacific slope of Panama, Chiriqui (David), Veraguas and Canal Zone.

Perissotriccus atricapillus (Lawrence)
Caribbean slope, Costa Rica to west Ecuador; very rare.
Panama. — Veraguas (Rio Calovevora), Darien (Permé, Obaldia).

Pseudotriccus pelzelni berlepschi Nelson
Eastern Darien (summit of Mt. Pirri).

Phylloscartes ventralis flavovirens (Lawrence)
Panama R. R. (the type); Port Antonio, Rio Chepo, Darien, 1♂, Mar. 15, 1927 (ex Smith in Havemeyer Coll.).

Capsiempis flaveola semiflava (Lawrence)
Nicaragua to Panama.
Panama. — Pacific slope Chiriqui and Veraguas; Canal Zone.

Serpophaga cinerea grisea Lawrence
Mts. of Costa Rica and west Panama in Subtropical Zone.
Panama. — Mts. of Chiriqui and Veraguas.

Mecocerculus superciliaris superciliaris (Sclater & Salvin)
Costa Rica and west Panama; very rare.
Panama. — Veraguas (2 spec.).

Mecocerculus superciliaris palloris Griscom
Eastern Panama and "Bogotá", Colombia.
Panama. — The type in A. M. N. H., Mt. Tacarcuna, Feb. 24, 1915.

Elaenia flavogaster subpagana Sclater & Salvin
Mexico to Panama.
Panama. — Throughout arid tropical areas, Pacific slope.

Elaenia chiriquensis chiriquensis Lawrence [includes *sordidata* Thayer & Bangs of Pearl Islands]
Costa Rica and Panama.
Panama. — Throughout arid tropics of Pacific slope.

Elaenia obscura frantzii Lawrence
Mts. of Guatemala to Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Elaenia gaimardii macilvainii Lawrence
Panama and Colombia.
Panama. — Tropical rain forest, Canal Zone and Darien; quite common.

Elaenia viridicata accola (Bangs)
Nicaragua to Panama.
Panama. — Western half, Pacific slope only.

Elaenia viridicata pallens (Bangs)
Panama to Venezuela.
Panama. — Canal Zone and Darien.

Sublegatus modestus glaber Sclater & Salvin
Panama to Venezuela.
Panama. — Pacific slope, Arid Tropical Zone, Chiriqui to Canal Zone and Pearl Islands.

Phaeomyias murina incompta (Cabanis & Heine)
Panama to Brazil.
Panama. — Arid plains near Agua Dulce.

Camptostoma obsoletum flaviventre Sclater & Salvin
Costa Rica and Panama.
Panama. — Pacific slope, Chiriqui to Rio Chepo, Darien; also Caribbean slope, eastern Darien.

Camptostoma obsoletum major Griscom
Pearl Islands, Bay of Panama.

Camptostoma obsoletum subsp.
Eastern Darien, Pacific slope (Cana)

Tyranniscus vilissimus parvus Lawrence
Nicaragua to Panama.
Panama. — Throughout.

Tyrannulus elatus panamensis Thayer & Bangs
Western Panama; Colombia and west Ecuador.
Panama. — Pacific slope in arid scrub, Chiriqui to Rio Chepo, Darien.

Acrochordopus zeledoni zeledoni (Lawrence)
Mts. of Costa Rica and west Panama; very rare.
Panama. — Volcan de Chiriqui (Boquete, 3 specs.).

Microtriccus brunneicapillus brunneicapillus (Lawrence)
Costa Rica to west Ecuador; rare.
Panama. — Canal Zone; Darien (Rio Chiman, Permé, Obaldia).

Leptopogon superciliaris hellmayri Griscom
Mts. of Costa Rica and west Panama; rare.
Panama. — Mts. of Chiriqui and Veraguas.

Leptopogon superciliaris troglodytes Griscom
Mts. of eastern Darien.

Leptopogon amaurocephalus faustus Bangs
Costa Rica and Panama in tropical rain forest; rare.
Panama. — Veraguas (2 records); Canal Zone.

Mionectes olivaceus olivaceus Lawrence
Costa Rica and western Panama.
Panama. — Throughout western half.

Mionectes olivaceus hederaceus Bangs
Panama to west Ecuador.
Panama. — Darien.

Pipromorpha oleaginea assimilis (Sclater)
Mexico to western Panama (Caribbean slope).
Panama. — Almirante region.

Pipromorpha oleaginea dyscola (Bangs)
Pacific slope, Costa Rica and west Panama.
Panama. — Forests of western Chiriqui.

Pipromorpha oleaginea lutescens Griscom
Forests of Veraguas (Pacific slope).

FAMILY HIRUNDINIDAE — Swallows

Riparia riparia riparia (Linnaeus)
North America, to South America in winter.
Panama. — A transient, rarely recorded.

Iridoprocne albilinea (Lawrence)
Mexico to Peru.
Panama. — Throughout.

Hirundo erythrogaster Boddaert
North America, to South America in winter.
Panama. — Common transient.

Progne chalybea chalybea (Gmelin)
Tropical America.
Panama. — Throughout, but rather local.

Neochelidon tibialis (Cassin)
Panama to west Ecuador.
Panama. — Canal Zone and Darien (Pacific slope); local.

Pygochelidon cyanoleuca (Vieillot)
Mts. of Costa Rica to Bolivia and Brazil.
Panama. — Mts. of Chiriqui and Veraguas in Subtropical Zone.

Pygochelidon patagonica patagonica (Lafresnaye & d'Orbigny)
Temperate South America, north in winter to Panama and Venezuela.
Panama. — Juan Mina, Rio Chagres, ♂ ad., July 17, 1923 (Chapin & Rogers)[1].

[1]cf. Chapman, Birds Ecuador, p. 558.

Petrochelidon albifrons albifrons (Rafinesque)
North America, south in winter to South America.
Panama. — A transient, recorded from Canal Zone only.

Petrochelidon albifrons tachina Oberholser
Mexican border region, probably to South America in winter.
Panama. — A transient; Veraguas (Griscom); Canal Zone.

Petrochelidon albifrons melanogaster (Swainson)
Northwestern Mexico and adjacent U. S., southward in winter.
Panama. — Darien (Obaldia) on migration.

Stelgidopteryx ruficollis uropygialis (Lawrence)
Nicaragua to west Ecuador.
Panama. — Western half (Caribbean slope), Canal Zone, Darien.

Stelgidopteryx rufieollis decolor Griscom
Pacific lowlands, Veraguas, Chiriqui and adjacent Costa Rica.

Stelgidopteryx ruficollis fulvipennis Sclater
Mts. of southern Mexico to Panama.
Panama. — Pico Calovevora, Veraguas; other records refer to *decolor*.

Stelgidopteryx ruficollis serripennis (Audubon)
Eastern U. S., south in winter to Panama.
Panama. — Almirante, Feb. 16, 1926, the only definite record.

FAMILY CORVIDAE — Crows, Jays

Cyanocorax affinis zeledoni Ridgway
Costa Rica and Colombia.
Panama. — Throughout.

Cyanolyca argentigula blandita Bangs
Volcan de Chiriqui (7000 ft.).

Cyanolyca cucullata (Ridgway)
Mts. of Costa Rica and Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Psilorhinus mexicanus captus Kennard & Peters
Panama. — Almirante Region.

FAMILY CINCLIDAE — Dippers

Cinclus mexicanus ardesiacus Salvin
Mts. of Costa Rica and Panama.
Panama. — Mts. of Chiriqui and Veraguas.[1]

FAMILY TROGLODYTIDAE — Wrens

Heleodytes albobrunneus albobrunneus Lawrence
Savannas of Veraguas and near Panama City.

Heleodytes albobrunneus harterti Berlepsch
Extreme eastern Darien (both coasts) and adjacent Colombia.

Heleodytes zonatus costaricensis (Berlepsch)
Costa Rica and west Panama.
Panama. — Almirante and Chiriqui Lagoon.

Heleodytes zonatus panamensis Griscom
Mts. back of Santa Fé, Veraguas.

Thryothorus zeledoni (Ridgway)
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante region.

Thryothorus thoracicus (Salvin)
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante and Veraguas.

Thryothorus castaneus costaricensis (Sharpe)
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante region.

Thryothorus castaneus castaneus Lawrence
Veraguas (Rio Calovevora), Canal Zone and adjacent Darien.

Thryothorus nigricapillus schotti (Baird)
Extreme eastern Darien (Pacific slope) and adjacent Colombia.

Thryothorus nigricapillus reditus (Griscom)
Extreme eastern Darien (Caribbean slope) and adjacent Colombia.

Thryothorus semibadius Salvin
Pacific coast, Costa Rica and west Panama.
Panama. — Coastal forests of western Chiriqui.

[1]Specimens in Brit. Mus. examined.

Thryothorus rufalbus castanonotus (Ridgway)
Pacific slope, Nicaragua to Panama.
Panama. — Arid Tropical Zone, Chiriqui to Rio Chepo, Darien.

Thryothorus leucopogon leucopogon (Salvadori and Festa)
Extreme eastern Darien (Pacific slope) to west Ecuador; very rare.
Panama. — Tapalisa and Cupé River.

Thryothorus leucopogon grisescens (Griscom)
Extreme eastern Darien (Caribbean slope, Permé and Obaldia).

Thryothorus leucotis leucotis Lafresnaye
Panama and Colombia.
Panama. — Darien, Caribbean slope, Permé.

Thryothorus leucotis galbraithii Lawrence
Canal Zone and most of Darien in humid tropics.

Thryothorus leucotis conditus (Bangs)
Pearl Islands, Bay of Panama.

Thryothorus modestus elutus (Bangs)
Arid Tropical Zone, Chiriqui to Rio Chepo, Darien.

Thryothorus atrogularis Salvin
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante region.

Thryothorus spadix xerampelinus Griscom[1]
Pacific slope of extreme eastern Darien, Tropical Zone (Cana).

Thryothorus fasciato-ventris melanogaster (Sharpe)
Pacific slope forests of Chiriqui and Veraguas and adjacent Costa Rica.

Thryothorus fasciato-ventris albigularis (Sclater)
Canal Zone, Darien and adjacent Colombia.

Thryothorus rutilus hyperythrus Salvin & Godman
Western Costa Rica and Panama.
Panama. — Arid Tropical Zone, Pacific slope, Chiriqui to Rio Chepo, Darien.

[1]All existing specimens of both races examined. The Cana series strikingly distinct from the type. Birds from Mt. Tacarcuna (higher altitudes) resemble the other Colombian specimen (Gallera, 7000 ft.), and these are intermediate between the type of *spadix* and the series of *xerampelinus*, but nearer the latter, True *spadix* is probably confined to the lower altitudes of southwestern Colombia, where the rainfall is 300–400 inches annually.

Cistothorus platensis lucidus Ridgway
High savannas of Costa Rica and western Chiriqui; little known.

Troglodytes musculus intermedius Cabanis
Southern Mexico to west Panama.
Panama. — Almirante region.

Troglodytes musculus inquietus Baird
Whole of Panama (except Almirante) and adjacent Costa Rica.

Troglodytes ochraceus ligea Bangs
Subtropical Zone, Volcan de Chiriqui; rare, 9 birds seen.

Troglodytes ochraceus remotus Griscom[1]
Mts. of eastern Chiriqui (Cerro Flores) and Veraguas.

Troglodytes ochraceus festivus Nelson
Summit of Mt. Pirri, eastern Darien.

Thryorchilus browni browni (Bangs)
Summit of Volcan de Chiriqui, above tree-line.

Henicorhina leucosticta tropaea Bangs & Peters
Caribbean forests of Central America.
Panama. — Caribbean slope of western half and Canal Zone.

Henicorhina leucosticta pittieri Cherrie
Forests of Pacific slope, Veraguas and Chiriqui and adjacent Costa Rica.

Henicorhina leucosticta darienensis Hellmayr
Eastern Darien, westward limits unknown.

Henicorhina leucophrys collina Bangs
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Henicorhina leucophrys leucophrys (Tschudi)
Mts. of Panama to Peru.
Panama. — Eastern Darien (Mt. Tàcarcuna).

Cyphorinus phæocephalus lawrencii Sclater[2]
Panama, from Canal Zone eastward.

Cyphorhinus phæocephalus infuscatus Zimmer
Caribbean coast of Costa Rica and western Panama (Almirante).

[1]Five additional specimens from Veraguas examined.
[2]Includes *assimilis* Todd. c/o Zimmer, Amer. Mus. Novit., no. 573, 1932, pp. 1–4.

Microcerculus marginatus philomela (Salvin)
Guatemala to Panama; rare and little known.
Panama. — Humid tropical areas, scattered records throughout.

FAMILY MIMIDAE — Mockingbirds, etc.

Donacobius atricapillus brachypterus Madarasz
Arid Tropical Zone Pacific slope of eastern Darien and north Colombia.

Dumetella carolinensis (Linnaeus)
U.S.A., wintering south to Panama.
Panama. — Almirante (common), Chiriqui (once), Canal Zone (once).

Rhodinocichla rosea eximia Ridgway
Arid Tropical Zone, Pacific slope of western Panama and adjacent Costa Rica.

FAMILY TURDIDAE — Thrushes, Solitaires

Myadestes melanops Salvin
Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas.

Myadestes coloratus Nelson
Mts. of eastern Darien.

Turdus assimilis enephosa Bangs
Mts. of Chiriqui, Veraguas, and adjacent Costa Rica, in Subtropical Zone.

Turdus daguae Berlepsch
Eastern Darien (Pacific slope) and adjacent Colombia.

Turdus obsoletus obsoletus Lawrence
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas, uncommon.

Turdus obsoletus colombianus Hartert & Hellmayr[1]
Mts. of east Panama and western Colombia.
Panama. — Mts. of eastern Darien.

[1]Birds from the mts. of eastern Darien may not be *colombianus*, but they most certainly are not *obsoletus* of western Panama.

Turdus grayi casius (Bonaparte)
Costa Rica to Darien.
Panama. — Caribbean slope (Almirante); Pacific slope, Chiriqui to Canal Zone.

Turdus plebejus plebejus Cabanis
Mts. of Costa Rica and west Panama.
Panama. — Subtropical Zone, mts. of Chiriqui and Veraguas, common.

Turdus nigrescens Cabanis
Mts. of Costa Rica and west Panama.
Panama. — Temperate Zone, Volcan de Chiriqui.

Hylocichla mustelina (Gmelin)
Eastern U. S., south in winter to Panama.
Panama. — Almirante region.

Hylocichla fuscescens fuscescens (Stephen)
Eastern North America, wintering in South America.[1]
Panama. — Canal Zone (Lion Hill and Cristobal) on migration.

Hylocichla minima aliciae (Baird)
North America, wintering in South America.[1]
Panama. — Volcan de Chiriqui (once) on migration; Almirante (once).

Hylocichla ustulata swainsoni (Tschudi)
Eastern North America, wintering in South America.
Panama. — Common spring and fall transient throughout; casual in summer.

Catharus mexicanus fumosus Ridgway
Mts. of Costa Rica and west Panama; rare.
Panama. — Mts. of Chiriqui and Veraguas (Caribbean slope).

Catharus fuscater hellmayri Berlepsch
Mts. of Costa Rica and Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Catharus fuscater fuscater (Lafresnaye) [includes *mirabilis* Nelson]
Mts. of Panama to Ecuador.
Panama. — Mts. of eastern Darien.

[1]Almost unknown as a transient.

Catharus frantzii frantzii Cabanis
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Catharus griseiceps griseiceps Salvin
Pacific slope, Mts. of Veraguas and eastern Chiriqui (Cerro Flores), 3000–5500 ft.

Catharus griseiceps russatus Griscom
Volcan de Chiriqui and adjacent southwest Costa Rica.

Catharus gracilirostris accentor Bangs (includes *bensoni* Griscom)
Volcan de Chiriqui, Temperate Zone and Cerro Flores.

FAMILY ZELEDONIIDAE — Wren-Thrushes

Zeledonia coronata Ridgway
Mts. of Costa Rica and west Panama.
Panama. — Highest mts. of Chiriqui and Veraguas.

FAMILY SYLVIIDAE — Warblers, Gnatcatchers

Polioptila bilineata bilineata (Bonaparte)
Southern Central America to northwestern Peru.
Panama. — Throughout.

Polioptila schistaceigula Hartert
Panama, Colombia and west Ecuador.
Panama. — Spec. in Paris Museum from "Gulf of Darien" coll. by Viguier (*fide* Hellmayr).

Ramphocaenus rufiventris rufiventris (Bonaparte)
Mexico to west Ecuador.
Panama. — Throughout forested areas.

Microbates cinereiventris semitorquatus (Lawrence)
Nicaragua to west Panama, Caribbean slope.
Panama. — Caribbean slope, western half.

Microbates cinereiventris magdalenae Chapman
Eastern Darien (Caribbean slope) and adjacent Colombia.

Microbates cinereiventris cinereiventris (Sclater)
Panama to west Ecuador.
Panama. — Eastern Darien (Pacific slope).

FAMILY MOTACILLIDAE — Wagtails, Pipits

Anthus lutescens parvus (Lawrence)
Savannas, Pacific slope of Panama, Chiriqui to Panama City.

FAMILY BOMBYCILLIDAE — Waxwings

Bombycilla cedrorum Vieillot
North America, south in winter to Panama.
Panama. — "Chiriqui" (coll. by Arcé, spec. in Turin Museum).

FAMILY PTILOGONATIDAE — Silky Flycatchers

Ptilogonys caudatus Cabanis
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui, Temperate Zone.

Phainoptila melanoxantha melanoxantha Salvin
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (4000–11000 ft.).

Phainoptila melanoxantha minor Griscom
Mts. of eastern Chiriqui and Veraguas.

FAMILY CYCLARHIDAE — Pepper-Shrikes

Cyclarhis flaviventris subflavescens Cabanis
Costa Rica and western Panama.
Panama. — Pacific lowlands, Chiriqui.

Cyclarhis flaviventris coibae Hartert
Coiba Island and adjacent coast of Veraguas.

FAMILY VIREOLANIIDAE — Shrike-Vireos

Smaragdolanius pulchellus verticalis (Ridgway)
Caribbean lowlands, Nicaragua to Panama; rare in collections.
Panama. — Veraguas (Rio Calovevora).

Smaragdolanius pulchellus viridiceps (Ridgway).
Canal Zone, Veraguas (Pacific slope); Rio Chepo, Darien.

Smaragdolanius eximius mutabilis (Nelson)
Extreme eastern Darien (Pacific slope).

FAMILY VIREONIDAE — Vireos

Vireo carmioli Baird
Volcan de Chiriqui and mts. of Costa Rica.

Vireo flavifrons Vieillot
Eastern U. S., south in winter to Colombia.
Panama. — Decidedly uncommon winter visitant.

Vireo calidris barbatula (Cabanis)
Greater Antilles, in winter to South America.
Panama. — Canal Zone and Darien (Obaldia) on migration.

Vireo olivaceus (Linnaeus)
Eastern U. S., south in winter to Brazil.
Panama. — Common transient throughout.

Vireo flavoviridis flavoviridis (Cassin)
Mexico and northern Central America, wintering in South America.
Panama. — A transient, only 2 definite records.

Vireo flavoviridis insulanus Bangs
Summer resident in southern Central America.
Panama. — Chiefly Arid Tropical Zone, Chiriqui to Darien and Pearl Islands.

Vireo philadelphicus (Cassin)
Boreal North America, south in winter to Panama.
Panama. — Western half, chiefly in the mts.

Vireo josephae chiriquensis (Bangs)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Hylophilus decurtatus decurtatus (Bonaparte)
Mexico to western Panama.
Panama. — Pacific slope, Chiriqui and Veraguas.

Hylophilus decurtatus pusillus Lawrence
Caribbean slope, Nicaragua to Panama.
Panama. — Caribbean slope, Almirante to Canal Zone.

Hylophilus minor darienensis (Griscom)
Humid forests of Darien (Rio Chepo eastward).

Hylophilus ochraceiceps ochraceiceps Sclater
Mexico to west Panama.
Panama. — Western Chiriqui (Pacific slope).

Hylophilus ochraceiceps nelsoni (Todd)
Pacific slope, coastal forests of Veraguas to Rio Chepo, Darien; rare.

Hylophilus ochraceiceps bulunensis Hartert
Panama to west Ecuador.
Panama. — Extreme eastern Darien (both slopes).

Hylophilus aurantiifrons aurantiifrons Lawrence
Canal Zone (Caribbean side) to coast of Colombia.

Hylophilus viridiflavus Lawrence [includes *pallescens* Davison]
Arid Tropical Zone, Pacific slope of Panama, Rio Chepo, Darien to Chiriqui, and adjacent Costa Rica.

FAMILY COEREBIDAE — Honey-Creepers

Coereba mexicana mexicana (Sclater)
Mexico to Panama.
Panama. — Throughout, except eastern Darien.

Coereba mexicana columbiana (Cabanis)
Panama and Colombia.
Panama. — Eastern Darien (both coasts).

Coereba cerinoclunis Bangs
Pearl Islands, Bay of Panama.

Diglossa plumbea plumbea Cabanis
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (5000–7000 ft.).

Diglossa plumbea veraguensis Griscom
Mts. of eastern Veraguas.

Dacnis cayana ultramarina Lawrence
Caribbean slope Nicaragua to Panama.
Panama. — Caribbean slope western half; Darien (very common).

Dacnis cayana collaina Bangs
Pacific slope of Chiriqui and Veraguas, and adjacent Costa Rica.

Dacnis venusta venusta Lawrence
Costa Rica and western Panama; uncommon.
Panama. — Pacific slope of Chiriqui.

Dacnis venusta fuliginata Bangs
Extreme eastern Darien and adjacent Colombia.

Dacnis viguieri Oustalet
Panama ("coast of Gulf of Darien"); the type unique.[1]

Cyanerpes cyaneus cyaneus (Linnaeus)
Mexico to Brazil.
Panama. — Lacking only in the heavy rain forest areas.

Cyanerpes lucidus isthmicus Bangs
Nicaragua to Panama.
Panama. — Rain forest areas; also western Chiriqui.

Chlorophanes spiza arguta Bangs & Barbour
Whole of Panama and adjacent Costa Rica.

FAMILY COMPSOTHLYPIDAE — Wood Warblers

Mniotilta varia (Linnaeus)
U.S.A., wintering south to Colombia.
Panama. — Throughout in winter.

Protonotaria citrea (Boddaert)
Southern U. S., to Colombia in winter.
Panama. — Common throughout.

Helmitheros vermivorus (Gmelin)
Eastern U. S., south in winter to Panama.
Panama. — Veraguas (Chitrá, Santa Fé, 2 records); Rio Chepo, Darien.

Vermivora chrysoptera (Linnaeus)
Eastern U. S., south in winter to Colombia.
Panama. — Regular in mts. of western half; few records elsewhere.

Vermivora pinus (Linnaeus)
Eastern U. S., south in winter to Colombia.
Panama. — Darien (Port Antonio, Rio Chepo, March 7, 1927, in Coll. Havemeyer).

Vermivora peregrina (Wilson)
Eastern North America, south in winter to Colombia.
Panama. — Western half (common); Pearl Islands (once); Darien (once).

[1]Type in Paris Museum examined July, 1934 by L. G.

Vermivora gutturalis (Cabanis)
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui (above 7000 ft.).

Compsothlypis pitiayumi speciosa Ridgway
Nicaragua to Panama, chiefly in the mts.
Panama. — Pacific slope, Chiriqui and Veraguas above 1500 ft.

Compsothlypis pitiayumi nana Griscom
Arid Tropical Zone, extreme eastern Darien (Pacific slope).

Ateleodacnis leucogenys panamensis Griscom
Arid Tropical Zone, eastern Darien (Cape Garachiné).

Dendroica aestiva aestiva (Gmelin)
Eastern North America, to Brazil in winter.
Panama. — Common winter resident throughout.

Dendroica aestiva sonorana Brewster
S. w. U. S., to Colombia in winter.
Panama. — Recorded from Veraguas and Canal Zone.

Dendroica aestiva rubiginosa (Pallas)
N. w. America, south in winter to Panama.
Panama. — Almirante, Canal Zone, Darien.

Dendroica erithachorides erithachorides Baird
Panama and Caribbean coast of Colombia.
Panama. — Coastal mangrove swamps, Almirante to Canal Zone.

Dendroica erithachorides aequatorialis Sundevall
Pacific coast of Panama, Agua Dulce to Cape Garachiné.

Dendroica coronata (Linnaeus)
Eastern North America, to Colombia in winter.
Panama. — Rare winter visitant, Almirante, Canal Zone, Pearl Isl.

Dendroica magnolia (Wilson)
Eastern North America, south to Panama in winter.
Panama. — Rare in winter; Veraguas; Canal Zone; Almirante.

Dendroica virens virens (Gmelin)
Eastern North America, south in winter to Panama.
Panama. — Chiriqui and Veraguas (common); Canal Zone.

Dendroica cerulea (Wilson)
Southern U.S.A., wintering in South America.
Panama. — Caribbean slope on migration (Veraguas, Canal Zone).

Dendroica pensylvanica (Linnaeus)
Eastern U.S.A., wintering in Central America.
Panama. — Western half (common); few Darien records.

Dendroica fusca (Muller)
Eastern North America, wintering in South America.
Panama. — Regular transient, chiefly Caribbean slope.

Dendroica castanea (Wilson)
Eastern North America, south in winter to Colombia.
Panama. — Western half, a transient on Caribbean slope; common all winter Canal Zone and Darien.

Seiurus aurocapillus (Linnaeus)
Eastern North America, south in winter to Colombia.
Panama. — Uncommon winter visitant, recorded only twice in Darien.

Seiurus noveboracensis noveboracensis (Gmelin)[1]
Eastern North America, to South America in winter.
Panama. — Throughout in winter.

Seiurus noveboracensis limnaeus McCabe and Miller
British Columbia, south in winter to Panama.
Panama. — Puerto Armuelles, Chiriqui, Nov. 10, 1929.

Seiurus noveboracensis notabilis Ridgway[2]
Western North America, to South America in winter.
Panama. — Very common throughout.

Seiurus motacilla (Vieillot)
Southern U.S.A., south in winter to Colombia.
Panama. — Rare winter visitant, seldom recorded.

Oporornis formosus (Wilson)
Southern U.S.A., south in winter to Colombia.
Panama. — Throughout in winter; quite common.

Oporornis philadelphia (Wilson)
Eastern North America, to South America in winter.
Panama. — Throughout in winter, but uncommon.

[1]Undoubtedly including specimens of the recently described *limnaeus* (c/o Condor, 1933, pp. 192–197).

[2]The commonest type of Water-thrush in Central America is the intermediate bird breeding in Central North America.

Oporornis tolmiei (Townsend)
Western U.S.A., south in winter to Colombia.
Panama. — Recorded only from the Volcan de Chiriqui.

Geothlypis trichas brachidactyla (Swainson)
Eastern North America, to Panama in winter.
Panama. — Once (Volcan de Chiriqui, Arcé).

Geothlypis chiriquensis Salvin[1]
Savannas at base of Volcan de Chiriqui; very rare.

Geothlypis semiflava bairdi Nutting
Caribbean slope, Honduras to Panama.
Panama. — Almirante region.

Chamaethlypis poliocephala ridgwayi Griscom
Savannas of western Chiriqui and adjacent Costa Rica.

Icteria virens virens (Linnaeus)
Southern U.S.A., south in winter to Panama.
Panama. — Once, Almirante, Jan. 16, 1929,

Wilsonia citrina (Boddaert)
Southern U.S.A., south in winter to Panama.
Panama. — Recorded only from the Canal Zone.

Wilsonia pusilla pileolata (Pallas)
Western North America, south in winter to Panama.
Panama. — Fairly common in Chiriqui and Veraguas; Canal Zone.

Wilsonia pusilla chrysecla Ridgway
Pacific coast region, south in winter to Panama.
Panama. — One record, Volcan de Chiriqui.

Wilsonia canadensis (Linnaeus)
Eastern North America, wintering in eastern South America.
Panama. — Regular transient throughout.

Setophaga ruticilla (Linnaeus)
Eastern North America, south in winter to Ecuador.
Panama. — Throughout in winter.

Myioborus verticalis aurantiacus (Baird)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas (above 3500 ft.).

[1]Type series in Brit. Mus. examined.

Myioborus verticalis pallidiventris (Chapman)
Mts. of Panama and northwestern South America.
Panama. — Mts. of eastern Darien.

Myioborus torquatus (Baird)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas (above 5000 ft.).

Basileuterus tacarcunae Chapman
Mts. of eastern Darien.

Basileuterus tristriatus melanotis Lawrence
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Basileuterus tristriatus chitrensis Griscom
Mts. of Veraguas.

Basileuterus culicivorus godmani Berlepsch
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas (above 3000 ft.)

Basileuterus melanogenys eximius Nelson
Volcan de Chiriqui (above 5000 ft.).

Basileuterus bensoni Griscom
Mts. of Veraguas.

Basileuterus ignotus Nelson
Summit of Mt. Pirri, eastern Darien, the type unique.

Basileuterus delattrii mesochrysus Sclater
Costa Rica to Colombia.
Panama. — Arid Tropical Zone, Pacific slope, Chiriqui to Darien.

Phœothlypis leucopygia leucopygia (Sclater & Salvin)
Caribbean slope, Nicaragua to Panama.
Panama. — Almirante to Rio Calovevora, Veraguas.

Phœothlypis leucopygia veraguensis (Sharpe)
Pacific slope of Panama (Canal Zone westward) and adjacent Costa Rica.

Phaeothlypis semicervina semicervina (Sclater)
Panama and Colombia.
Panama. — Canal Zone and throughout Darien.

FAMILY ICTERIDAE — Caciques, Orioles, Blackbirds

Zarhynchus wagleri ridgwayi vanRossem
Nicaragua to west Ecuador.
Panama. — Throughout.

Gymnostinops montezuma (Lesson)
Mexico to Panama.
Panama. — Almirante; Canal Zone.

Gymnostinops guatimozinus (Bonaparte)
Panama and Colombia.
Panama. — Eastern Darien, Pacific lowlands.[1]

Ostinops decumanus (Pallas)
Panama to Brazil and Guiana.
Panama. — Very local; Pacific slope, Chiriqui to eastern Darien.

Cacicus vitellinus Lawrence
Canal Zone, Darien and adjacent Colombia.

Cacicus microrhynchus (Sclater & Salvin)
Nicaragua to Colombia.
Panama. — Throughout Caribbean slope.

Amblycercus holosericeus holosericeus (Lichtenstein)
Mexico to Panama.
Panama. — Throughout.

Psomocolax oryzivorus impacifus Peters
Mexico to Panama.
Panama. — Western half.

Psomocolax oryzivorus violeus (Bangs)
Panama and northern Colombia.
Panama. — Canal Zone and Darien.

Dolichonyx oryzivorus (Linnaeus)
U.S.A., wintering in southern South America.
Panama. — Canal Zone and Darien on migration.

Molothrus bonariensis subspecies
Darien to west Ecuador.
Panama. — Darien, Rio Tuyra, 1 juv. (cf. Friedmann, Auk, 1927, p. 502).

[1]Small series in A. M. N. H. from Tapalisa and El Real.

Tangavius aeneus aeneus (Wagler)
Texas to Panama.
Panama. — Pacific slope in arid tropical lowlands east to Rio Chepo.

Leistes militaris (Linnaeus)
Panama to Guiana.
Panama. — Savannas of Pacific slope, Chiriqui to Panama City.

Sturnella magna subulata Griscom
Savannas of Chiriqui, Veraguas and Cocle.

Icterus galbula (Linnaeus)
Eastern U. S., south in winter to Colombia.
Panama. — Common winter resident.

Icterus spurius (Linnaeus)
Southern U. S., south in winter to Colombia.
Panama. — Throughout Caribbean slope; rare on Pacific slope.

Icterus auricapillus Cassin
Panama to Venezuela, arid tropical.
Panama. — Darien (Rio Tuyra).[1]

Icterus chrysater giraudii Cassin
Interior of Veraguas, Canal Zone, Darien and Colombia.

Icterus xanthornus xanthornus (Gmelin)
Colombia to Trinidad.
Panama. — "Isthmus of Panama", in Brussels Museum.[2]

Icterus prosthemelas (Strickland)
Caribbean slope, Mexico to Panama.
Panama. — Almirante region.

Icterus mesomelas salvini Cassin[3]
Nicaragua to Colombia.
Panama. — Rain forest areas.

Cassidix mexicanus assimilis (Sclater)
Pacific slope, Nicaragua to Colombia.
Panama. — Pacific slope, chiefly coastal.

[1]3 spec. in A. M. N. H. from Cituro, Cupe River.
[2]Locality almost certainly erroneous, and requiring confirmation after so many years of exploration.
[3]Specimens from extreme eastern Darien may be *carrikeri* Todd.

FAMILY TERSINIDAE — Swallow-Tanagers[1]

Tersina viridis occidentalis Sclater
Panama to west Brazil.
Panama. — Eastern Darien.

FAMILY THRAUPIDAE — Tanagers

Chlorophonia callophrys (Cabanis)
Mts. of Costa Rica and Panama.
Panama. — Mts. of Chiriqui and Veraguas (above 3500 ft.).

Tanagra elegantissima (Bonaparte)
Mts. of Mexico to west Panama.
Panama. — Mts. of Chiriqui and Veraguas (above 3500 ft.).

Tanagra xanthogastra chocoensis (Hellmayr)
Western Colombia and extreme eastern Darien.

Tanagra anneae rufivertex (Salvin)
Caribbean lowlands of Veraguas (common).

Tanagra anneae subsp.
1♂ ad., base of Mt. Tacarcuna, eastern Darien.

Tanagra gracilis (Cabanis)
Pacific slope of western Chiriqui and Costa Rica.

Tanagra luteicapilla (Cabanis)
Nicaragua to Panama.
Panama. — Whole western half east to Rio Chepo, Darien.

Tanagra olivacea humilis (Cabanis)
Guatemala to west Ecuador
Panama. — Common throughout forested areas.

Tanagra fulvicrissa fulvicrissa (Sclater)
Tropical rain forests, Chiriqui and Veraguas through Darien to western Colombia.

Tanagra gouldi praetermissa Peters
Caribbean slope, Mexico to Panama (as to this race).
Panama. — Almirante region.

Tanagra lauta lauta Bangs & Penard.
Mexico to west Panama.
Panama. — Volcan de Chiriqui (Boquete, 1 record).

[1] *Procnias* Illiger is now applied to the bell-birds of the family Cotingidae. It is consequently improper to use the same name for this family, and we must use the next available name, *Tersina* Vieillot, 1819. *Tersa* Vieillot, 1816, is not available until the "Tersine" of Buffon is identified, which appears impossible.

Tanagra crassirostris (Sclater)
S. w. Costa Rica to northern Colombia.
Panama. — Pacific slope (Chiriqui to Rio Chepo, Darien) and Caribbean slope, Canal Zone eastward.

Tangara florida florida (Sclater & Salvin)
Caribbean slope, Costa Rica and Panama (Chiriqui and Veraguas).

Tangara guttata eusticta Todd
Mts. of Costa Rica and Panama, in Subtropical Zone.
Panama. — Volcan de Chiriqui; mts. of eastern Darien.

Tangara icterocephala (Bonaparte)
Mts. of Costa Rica to west Ecuador, in Subtropical Zone.
Panama. — Mts. of Chiriqui and Veraguas; common.

Tangara larvinia dalmasi (Hellmayr)
Caribbean slope, mts. of Chiriqui and Veraguas; rare.

Tangara gyroloides bangsi (Hellmayr)
Mts. of Costa Rica and west Panama.
Panama. — Throughout Chiriqui and Veraguas (above 1500 ft.).

Tangara gyroloides gyroloides (Lafresnaye)
Mts. of eastern Darien and Colombia.

Tangara palmeri Hellmayr
Western Colombia and extreme eastern Darien.

Tangara inornata languens Bangs & Barbour
Canal Zone and whole of Darien; very common.

Tangara dowii (Salvin).
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Tangara fucosa Nelson
Summit of Mt. Pirri, eastern Darien (3 known specimens).

Tangara larvata franciscae (Sclater)
Costa Rica and whole of Panama east to Rio Chiman, Darien.

Tangara larvata fanny (Lafresnaye)
Extreme eastern Darien and Colombia.

Bangsia arcei (Sclater & Salvin)
Mts. of Veraguas; very rare.

Thraupis cana diaconus (Lesson)
Mexico to Panama.
Panama. — Common almost throughout, including Pearl Islands (= *dilucida*)

Thraupis cana cana (Swainson)
Panama and northwestern South America.
Panama. — Extreme eastern Darien (both slopes).

Thraupis palmarum atripennis Todd
Nicaragua to Colombia.
Panama. — Throughout the forested areas.

Ramphocelus passerinii Bonaparte
Caribbean slope, Mexico to Panama.
Panama. — Almirante region.

Ramphocelus costaricensis Cherrie [including *festae* Salvadori]
S. w. Costa Rica and western Chiriqui.

Ramphocelus dimidiatus dimidiatus Lafresnaye
Panama. Colombia and Venezuela.
Panama. — Darien.

Ramphocelus dimidiatus isthmicus Ridgway[1]
Definitely known only from the Canal Zone.

Ramphocelus dimidiatus albirostris Griscom
Pacific slope of western Chiriqui.

Ramphocelus dimidiatus limatus Bangs
Pearl Islands and Coiba Island.

Ramphocelus icteronotus Bonaparte[1]
Panama and Colombia.
Panama. — Tropical rain forests, western half (Cricamola) to Canal Zone and Darien.

Phlogothraupis sanguinolenta aprica Bangs
Costa Rica and west Panama, Caribbean slope.
Panama. — Almirante region.

Piranga rubra rubra (Linnaeus)
Southern U.S.A., south in winter to Peru.
Panama. — Common winter visitant throughout.

[1]Four other "species" are hybrids between these two species, mutants of one or the other, or erroneously ascribed to "Panama." (cf. Griscom, Auk, 1932, pp. 199–203.)

Piranga flava testacea Salvin & Godman
Mts. of Costa Rica to west Ecuador.
Panama. — Mts. of Chiriqui and Veraguas; also Cape Garachiné, Darien.

Piranga erythromelas Vieillot
Eastern U.S., south in winter to South America.
Panama. — Only 2 records on migration, Caribbean slope.

Piranga leucoptera latifasciata Ridgway
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Piranga bidentata citrea vanRossem
Mts. of Mexico to west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Chlorothraupis carmioli carmioli (Lawrence)
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante region.

Chlorothraupis carmioli magnirostris Griscom
Caribbean slope of Veraguas and adjacent mountains.

Chlorothraupis carmioli lutescens Griscom
Eastern Darien, chiefly Caribbean slope and base of mountains Pacific slope.

Chlorothraupis olivacea (Cassin)
Panama to Ecuador.
Panama. — Canal Zone and Darien, chiefly Pacific slope (coastal).

Habia rubica vinacea (Lawrence)
Costa Rica and Panama.
Panama. — Whole Pacific slope, but locally absent.

Habia fuscicauda fuscicauda (Cabanis)
Caribbean slope, Nicaragua to west Panama.
Panama. — Almirante region and perhaps Veraguas (the next?).

Habia fuscicauda erythrolaema (Sclater)
Panama and north Colombia.
Panama. — Canal Zone; probably also Caribbean slope of Darien.

Lanio leucothorax ictus Kennard & Peters
Almirante region.

Lanio leucothorax melanopygius Salvin & Godman
Pacific slope of Chiriqui and Veraguas and adjacent Costa Rica.

Heterospingus rubrifrons (Lawrence)
Costa Rica and Panama; very rare.
Panama. — Five records, tropical rain forest areas.

Tachyphonus rufus (Boddaert)
Costa Rica to Argentina.
Panama. — Caribbean slope and whole of Darien.

Tachyphonus axillaris (Lawrence)
Caribbean slope, Honduras to west Panama.
Panama. — Almirante region.

Tachyphonus luctuosus panamensis Todd
Canal Zone and Darien.

Tachyphonus delatrii Lafresnaye
Costa Rica to west Ecuador.
Panama. — Caribbean slope western half, and Pacific slope Darien.

Tachyphonus nitidissimus Salvin
Pacific slope of Chiriqui and Veraguas and adjacent Costa Rica.

Eucometis spodocephala stictothorax (Berlepsch)
Pacific slope of Chiriqui and Veraguas.

Eucometis cristata cristata (Du Bus)
Panama and Colombia.
Panama. — Canal Zone and Darien.

Chrysothlypis chrysomelas chrysomelas (Sclater & Salvin)
Caribbean slope, mts. of Veraguas and perhaps Chiriqui.[1]

Chrysothlypis chrysomelas ocularis Nelson
Summit of Mt. Pirri.

Chlorospingus ophthalmicus novicius Bangs
Volcan de Chiriqui and adjacent mts. of Costa Rica.

Chlorospingus pileatus pileatus Salvin
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui, chiefly Temperate Zone.

Chlorospingus pileatus diversus Griscom
Cerro Flores, eastern Chiriqui.

[1]The Costa Rica bird is an undescribed race.

Chlorospingus flavigularis hypophaeus Sclater & Salvin
Mts. of Veraguas, Caribbean slope; little known.

Chlorospingus flavigularis subsp.
Volcan de Chiriqui, Caribbean slope.

Chlorospingus punctulatus Sclater & Salvin
Mts. of Veraguas; little known.

Chlorospingus tacarcunae Griscom
Summit of Mt. Tacarcuna, eastern Darien.

Chlorospingus inornatus (Nelson)
Summit of Mt. Pirri, eastern Darien.

Hemithraupis flavicollis ornatus Nelson
Only known from Cana, eastern Darien.

Mitrospingus cassini cassini (Lawrence)
Panama to west Ecuador.
Veraguas (Caribbean slope) eastward.

Mitrospingus cassini costaricensis Todd
Eastern Costa Rica and Almirante, Panama.

FAMILY FRINGILLIDAE — Finches, Sparrows, etc.

Pheucticus tibialis Lawrence
Nicaragua to Panama; uncommon
Panama. — Tropical rain forests of western half (both slopes).

Hedymeles ludovicianus (Linnaeus)
Eastern North America, south in winter to Ecuador.
Panama. — Recorded from Chiriqui and the Canal Zone.

Guiraca caerulea caerulea (Linnaeus)
Southern U. S., south in winter to Panama.
Panama. — Almirante region (1 record).

Cyanocompsa cyanoides cyanoides (Lafresnaye)
Panama to Ecuador and Venezuela.
Panama. — Canal Zone and Darien.

Cyanocompsa cyanoides caerulescens Todd
Nicaragua to west Panama.
Panama. — Forests of western half.

Oryzoborus funereus Sclater
Mexico to west Ecuador.
Panama. — Throughout.

Sporophila schistacea crissalis Carriker
Chiriqui (Bugaba, 1 spec.) and Buenos Aires, s. w. Costa Rica (3 spec.).

Sporophila schistacea schistacea (Lawrence)
Canal Zone (1 spec.), Darien (common) and northern Colombia.

Sporophila minuta centralis Bangs & Penard
S. w. Costa Rica and west Panama.
Panama. — Locally common in savannas of Pacific slope east to Rio Chepo, Darien.

Sporophila gutturalis (Lichtenstein)
S. w. Costa Rica to Brazil.
Panama. — Canal Zone, a summer immigrant only.

Sporophila corvina (Sclater)
Caribbean slope, Mexico to west Panama.
Panama. — Almirante and Rio Calovevora, Veraguas.

Sporophila aurita aurita (Bonaparte)
S. w. Costa Rica to Colombia.
Panama. — Absent only from the Caribbean slope of western half.

Tiaris olivacea pusilla Swainson
Mexico to Colombia; local.
Panama. — Pacific slope, Chiriqui, Veraguas, Canal Zone.

Volatinia jacarini atroniteus Todd
Mexico to west Ecuador.
Panama. — Common throughout.

Amaurospiza concolor australis Griscom
Panama. — Volcan de Chiriqui (4 specs. in all); Canal Zone (once).

Spodiornis barrilesensis Davison[1]
Volcan de Chiriqui (1 spec.).

Pitylus grossus saturatus Todd [2]
Nicaragua to Canal Zone (Caribbean slope)
Panama. — Western half (Caribbean slope).

[1]Type examined; a remarkable find, generically distinct on the basis of bill structure, but obviously representing *jardinii* of Costa Rica, which is not subspecifically separable from Andean birds!

[2]An exceedingly poor race.

Pitylus grossus grossus (Linnaeus)
Panama to Bolivia.
Panama. — Eastern Darien.

Caryothraustes poliogaster scapularis (Ridgway)
Caribbean slope, Nicaragua to Panama.
Panama. — Western half (Caribbean slope) to Canal Zone.

Caryothraustes canadensis simulans Nelson
Only known from Cana, eastern Darien (2 spec.).

Saltator atriceps lacertosus Bangs
Caribbean slope, Costa Rica and Panama.
Panama. — Almirante region and Canal Zone.

Saltator maximus magnoides Lafresnaye
Caribbean slope, Guatemala to Panama.
Panama. — Almirante region.

Saltator maximus intermedius (Lawrence)
Pacific slope, Rio Chepo, Darien to Chiriqui and adjacent southwest Costa Rica.

Saltator maximus iungens Griscom
Only known from Cana, Darien.

Saltator striatipictus furax Bangs & Penard
S. w. Costa Rica and western Chiriqui (David).

Saltator striatipictus isthmicus Sclater
Arid Tropical Zone, savannas of Veraguas to Rio Chepo, Darien.

Saltator striatipictus speratus Bangs and Penard
Pearl Islands, Bay of Panama.

Saltator striatipictus striatipictus Lafresnaye
Panama to Trinidad.
Panama. — Cana, eastern Darien.

Spinus psaltria croceus Jouy
Highlands of Guatemala to Panama.
Panama. — Pacific slope of western half of Canal Zone.

Spiza americana (Gmelin)
Central U.S.A., south in winter to Colombia.
Panama. — Recorded throughout in winter.

Junco vulcani (Boucard)
Highest mts. of Costa Rica and Chiriqui.
Panama. — Summit of Volcan de Chiriqui (11,000 ft.).

Zonotrichia capensis costaricensis Allen
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Passerina cyanea (Linnaeus)
Eastern U.S., south in winter to Panama.
Panama. — Pacific slope of Chiriqui and Veraguas.

Passerina ciris ciris (Linnaeus)
Southern U. S., south in winter to Panama.
Panama. — Chiriqui (David).

Arremonops striaticeps richmondi Ridgway
Nicaragua to Panama.
Panama. — Western half.

Arremonops striaticeps striaticeps Lafresnaye
Eastern Panama and Colombia.

Emberizoides sphenurus hypochondriacus Hellmayr
Savannahs of western Chiriqui above David; little known.

Emberizoides sphenurus floresae Griscom
Cerro Flores, eastern Chiriqui.

Arremon aurantiirostris rufidorsalis Cassin
Caribbean slope of Costa Rica and Panama (Almirante region).

Arremon aurantiirostris aurantiirostris Lafresnaye
Pacific slope of Panama (Chiriqui to Rio Chepo, Darien) and adjacent Costa Rica.

Arremon aurantiirostris strictocollaris Todd
Eastern Darien (both slopes) and adjacent Colombia.

Lysurus crassirostris (Cassin)
Mts. of Costa Rica and west Panama.
Panama. — Mts. of Chiriqui and Veraguas.

Atlapetes gutturalis brunneseens Chapman
Volcan de Chiriqui, above 3500 ft.

Atlapetes gutturalis coloratus Griscom
Mts. of eastern Chiriqui and Veraguas.

Buarremon brunneinuchus (Lafresnaye)
Mts. of Mexico to Bolivia.
Panama. — Mts. of Chiriqui, Veraguas and Darien.

Buarremon atricapillus tacarcunae Chapman
Mts. of eastern Darien (Mt. Tacarcuna and Mt. Pirri).

Pselliophorus tibialis (Lawrence)
Mts. of Costa Rica and west Panama.
Panama. — Volcan de Chiriqui.

Pselliophorus luteoviridis Griscom
Mts. of eastern Chiriqui (Cerro Flores) and Veraguas.

Pezopetes capitalis Cabanis
Mts. of Costa Rica and Panama.
Panama. — Volcan de Chiriqui.

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MAMMALIAN LIFE HISTORIES FROM BARRO COLORADO ISLAND, PANAMA

By Robert K. Enders

With Five Plates

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No. 4.— *Mammalian Life Histories from Barro Colorado Island, Panama*

By Robert K. Enders

INTRODUCTION

The following contributions to the life histories of the mammals occurring on Barro Colorado Island and adjacent portions of the Canal Zone and the Republic of Panama are based on materials collected during four periods of study beginning in 1929 and extending to 1935.

Work was initiated June 19 and pursued until August 11, 1929. The second period of study extended from November 11, 1930, to March 3, 1931; while the third covered the period between February 20 and July 4, 1932. All of the time was spent on the Island with but occasional trips to the mainland until March 12, 1932, when a week was spent at the southern half of the Zone. On May 17 the base of operations was transferred to Summit while work was carried on in the new Forest Preserve and at Las Cascades Plantation, as well as in the Experimental Gardens. Headquarters were again moved on June 1 — this time to Alhajuela — for a period of four weeks. A fourth trip was made to study the areas about Salamanca on the Pequeni River and Peluca on the Boqueron River of the Chagres drainage system.

The studies extending from 1930 to 1932 were made while the writer was a fellow of the National Research Council working under the direction of Dr. Carl G. Hartman of the Department of Embryology, Carnegie Institution of Washington. The problem assigned was a study of the reproduction of *Marmosa*, involving a study of the life history of the genus. Dr. Hartman encouraged the collection of data on other species whenever possible. The last trip was made possible by a grant-in-aid from the National Research Council, having as its object the collection of series of animals for anatomical research, and the observation of faunal changes subsequent to the flooding of the rivers caused by the closing of Madden Dam.

Throughout these studies constant reference will be made to the outstanding work of E. A. Goldman, particularly his "Mammals of Panama," to which the reader is referred for a summary of the work done up to 1920. Other works published since that date to which frequent reference is made include Allen and Barbour, "Mammals

from Darien;" Chapman, "My Tropical Air Castle;" and Standley, "Flora of Barro Colorado Island, Panama."

Assistance of great value was received from so many persons that it is impossible to mention them by name, but to whom, however, the writer expresses his sincere thanks. Special acknowledgment is due first to Thomas Barbour, Director of the Institute for Research in Tropical America for his unfailing support; to A. G. Ruthven who encouraged the writer's first interest in this work; to L. R. Dice for his encouragement and support; to A. B. Howell for identification of some of the specimens, and constant encouragement; to James Zetek and his faithful staff for their cooperation; to J. B. Shropshire for aid in securing many of the mammals observed in captivity; to Ray Carpenter for many observations; to Otis Shattuck and Walter W. Boyd for photographs; and to Frank M. Chapman, who, through his personality and writings has served as an inspiration to the author. The United Fruit Company, through the Institute for Research in Tropical America, has always extended to the writer special rates for all trips. No one can work in the Canal Zone without being beholden to the officials of the Canal for many favors.

Financial support was received from the National Research Council; the William P. Harris, Jr. Fund, Museum of Zoölogy, University of Michigan; and Thomas Barbour. The U. S. National Museum furnished much collecting equipment. Acknowledgment is also made for the not inconsiderable aid of Major Goldman in the identification of some of the rarer rodents; also to the U. S. Biological Survey for the loan of material in connection with identification.

The nomenclature used throughout follows Miller, "List of North American Recent Mammals," and Standley, "Flora of Barro Colorado Island, Panama."

The following account of Barro Colorado Island is taken from various sources, chiefly Kenoyer (1929), some of which is quoted verbatim, as well as Standley (1928), Chapman (1929), Bennett (1929) and the Annual Reports of the Laboratory.

Barro Colorado was formed in 1914 when Gatun Dam backed up the waters of the Chagres River, making the lake that constitutes the central part of the Panama Canal. Gatun Lake covers 164 sq. mi. (420 sq. km.), has a maximum depth of 90 ft. (27.4 m.); its surface is 85 ft. (25.9 m.) above sea level, and is dotted with islands, the largest of which is Barro Colorado. This island lies between 9° 8′ and 9° 11′ north latitude, and between 79° 49′ and 79° 53′ west longitude. Its greatest length and its greatest width are each approximately 3 mi.

(4.8 km.), and it has an area of 6.64 sq. mi. There are more than forty miles of shore line. The highest point on the Island is 537 feet above sea level, an altitude of 452 feet above the lake. The Island was set aside in 1923 by the Governor of the Canal Zone as a biological reserve and the few small areas previously cultivated were then abandoned.

The annual rainfall (1926–1930) is 100.10 inches of which only 7.08 inches fell during the first four months of the year which constitute the dry season. With rare exceptions the temperature ranges from 70° to 90° F. The mean daily temperature remains practically the same from month to month; while the diurnal range varies from 5° to 15°. The relative humidity fluctuates between 77% in the dry season to 88% in June, July and August. The soil is Frijoles Clay, a dark red clay, moderately friable, susceptible to desiccation, hardening and cracking when very dry, and varying from 2 to 5 ft. in thickness. There are many outcrops of rock, chiefly Bohio conglomerate.

The following account and accompanying map are based upon the labors of many individuals. Thanks are chiefly due to Ray Carpenter who originated the idea and upon whom fell much of the labor of determining the limits of the various types; also to Frank M. Chapman for criticism and suggestions. Enlarged sections of an aerial photograph made by the U. S. Army Air Service were used as a check on the work in the forest. The writer begs to draw the attention of the reader to the fact that the map makes no pretense at being anything but a convenient method of outlining the types of forest which all but cover Barro Colorado Island, and that the criterion used over much of the area is that of tree size. The map is neither ecologic nor floristic except secondarily, nor is it intended to be.

"About half of it (the forest covering of the Island), that farthest from the Canal, is apparently primeval forest, although Standley (1927) points out that in a region which has been for over 400 years an important trade route it is difficult to prove that a given tract of land has not at some time been cleared and put under cultivation. The other half is occupied mainly by secondary forest, the largest trees of which scarcely exceed a foot in diameter at the base. Apparently it has become forested from a cleared condition of about fifty years ago." (Kenoyer, 1929, p. 201.)

In mapping, four types are recognized and illustrated in addition to the clearings. These clearings are the laboratory, the plantation, the new plantation, the areas about the two range lights at the end of Miller Trail, and about the tower. The area near the tower is permitted to grow up higher between cuttings than the other areas.

Although insignificant in area, these clearings are important as they are occupied by both plant and animal forms that do not occur in the other areas. Moreover, they may be considered as natural, for such small, isolated areas of clearing have occurred in the forest for many centuries, ever since the inhabitants of the region have practiced the "milpa" system of farming.

Next might be mentioned the areas that were cleared as late as 1920–1923. One such area occupies the neck and much of the end of the peninsula on which stands Bangs House, while another covers the region about the guard shanty. A third area which contains trees somewhat older lies on either side of Wheeler Trail from Stations 6 to 8.5, and from 10 to the tower clearing. This area extends as far as Wheeler 16, Armour 4, Zetek 1, while the other end is crossed by the cut-off from Wheeler to Miller. This is by far the largest area of this type and lies near the center of the Island.

It is here that an old French dump cart had been built into a stone furnace. From this construction and the bottles near by one can surmise the use to which it was put. The sugar cane which supplied the fermented juice was probably produced near at hand as cane is too heavy and bulky to transport over forest trails. Thus, the clearings cannot have been abandoned for over fifty years and probably only thirty. An abandoned cocoa plantation on Peña Blanca supports trees that are still older, as well as the large trees under the shade of which the cocoa grew.

The forest that covers the eastern and northern as well as other portions and much of the shore of the Island has been growing more or less undisturbed for a longer period as the trees are larger, in some areas approaching ten to twelve inches in diameter. Cultivation may have been abandoned over much of these areas as long as fifty years ago, but persisted until a later date in a few small clearings.

The fourth type is found in the oldest forests and differs from it chiefly by the abundance of palm trees. This type is indicated because it is avoided by the truly arboreal species of mammals.

The "primeval forest" is the most impressive type for the trees attain considerable size although the density of the stand is not as impressive as in northern forests. The ground is remarkably free from undergrowth over the level areas.

Although the second growth becomes very dry during the dry season, and some of the larger trees shed their leaves, the forest does not become brown and desiccated as do similar areas on the Pacific side of the Zone.

An observer, familiar with forest life in temperate regions, is astounded at both the many species and the large numbers of individuals supported by a forest such as that growing on Barro Colorado Island. Thus far fifty-three species of mammals have been recorded from the Island, and there are, doubtless, more. The large number of individuals supported by the area, particularly that of the larger species, is truly remarkable.

The explanation frequently given in this case is that, as Gatun Dam filled, the mammals were forced to take refuge on higher ground and were thus marooned on the Island. Like Chapman (1929, p. 5), the writer very much doubts this easy explanation, and adds to the arguments advanced by that writer the fact that an unnatural concentration forced upon a fauna from 1910 to 1914 would not persist in 1932. There is, broadly speaking, no sign of a diminution of the numbers of mammals. On the contrary, some, such as the Coati, have very definitely increased.

In such a forest the food supply does not fluctuate as it does in a region of more decided seasonal changes. The rain forest supplies leaves, fruit, nuts, and roots at all seasons of the year, not always with the same lavishness, but abundantly enough to carry a large population. Some of the carnivors eat fruit, and many other species of mammals are omnivorous which increases the carrying power of the area.

Nowhere in the writer's experience has he encountered as great a diversity of habitat, a greater concentration of many species of mammals, as occurs on the 4,000 acres or so that comprise Barro Colorado Island.

That a similar concentration of large mammals is not found elsewhere in the Canal Zone nor in the adjacent portions of the Republic can be explained upon the basis of the clearing of the land and the constant hunting to which all large mammals are subjected. The concentration of rodents, on the other hand, is more marked when conditions more favorable to them are brought about by human occupation. Hunting without clearing is effective in destroying the larger mammals even though the smaller arboreal forms persist.

How many individuals of each of the species of mammals do we have on the Island? Except in the case of the Howler Monkey where the careful, accurate work of Carpenter has given us the numbers of this unique animal we have no check.

Casual observations cannot be relied upon. So many of the mammals are able to escape discovery by taking to or staying under cover

that hunting does not give one a true cross section. Moreover, many of the mammals are nocturnal, a number are arboreal, and where the forest canopy is about ninety feet above one, the observer has scant opportunity for detecting their presence. Not all nocturnal mammals can be "shined" and specific determinations are difficult even using two powerful lights. The same difficulty is experienced with many species the eyes of which do reflect the light. Chance, too, is a factor.

Traps are no more accurate. In the first place, it is difficult to find places to set traps, particularly for mammals that are arboreal or semi-arboreal. Despite the fact that many species are omnivorous, the problem of bait is acute because of ants. Moreover, when food is abundant, as it is at various seasons of the year, baiting is of no use, as no bait that can be offered is more attractive than certain natural foods.

Observations made at one season of the year may not be applicable a few weeks later. Not only do the various species shift their feeding grounds with the ripening of certain fruits and nuts, but there are, superimposed upon shifts in range due to changing conditions in food supply, shifts caused by the changes of season. This may be illustrated by the shifts in wallows of the tapir and peccaries, to cite a conspicuous, direct effect of changing hydrographic conditions; or the changes in distribution of the Talamanca Rice Rat, or the Pygmy Rice Rat, which are less conspicuous but just as definite. And the carnivors follow their prey in these shifts.

Thus it comes about that one may be led to believe that a certain species is all too abundant at one time and then to wonder why all have disappeared when a change in food supply or season or both brings about a shift away from what the observer has come to consider their usual haunts. As an example of one of these shifts, the conditions at the end of March 1932, may be cited. Some of the foods maturing in March flower in November. The November before, 30.04 inches of rain fell which might have interfered with fertilization, or destroyed the young fruit. Regardless of the cause, the almendro crop which is an important source of food at this time of year for many species of mammals failed, and food was very scarce. Mammals such as the White-lipped Peccary were forced into the clearing for food; the Collared Peccary ate foods usually scorned. Coati were abundant, as were *Didelphis*. Some banana trees were pushed over and the green bananas eaten; pineapples and papaya were eaten before ripening. Out of a dozen traps, six would show the effect of tooth or claw because some large animal had attempted to get at the bait within or the captured specimen. A large live trap, banana

baited, was sprung almost every night. Coati thus taken were deported to the other side of Gatun Lake without any apparent diminution of the original numbers.

Then conditions changed almost overnight. No small mammals entered the traps, neither did large mammals disturb them. Coati, peccary, *Didelphis*, and fruit-eating bats were nowhere to be seen. Only small rodents were left about the clearing; everything else, apparently, having moved. Trap lines along the streams yielded nothing but Spiny Rats, and few of them. Imperfect bunches of bananas discarded in the clearing were not consumed. The finca was deserted.

Having observed such a swift shift before, it was not such a great surprise to the writer. The mammals had found a food supply in the forest. When a similar change took place in December, 1930, it was due to the ripening of Almendro nuts and camito or Star-apple. In 1931–32, both these foods failed so the pressure upon the clearing became greater and was prolonged by several months. Thus, when, at the end of March, 1932, the figs began to ripen, the mammals left the clearing for their usual feeding grounds. Within a week, conditions had changed and the animals followed the food supply. Not until conditions altered with the advancing rainy season would the mammals again be abundant about the clearing.

With these changes in mind the reader will understand some of the difficulties encountered in attempting to determine the numbers of mammals. Nevertheless, wherever an estimate of numbers is possible, it will be given together with the basis upon which the estimate is made. This appears to be the only method possible with our present knowledge.

The problems of mammal distribution on the Island are intricately associated with food, the distribution of primary and secondary forest, scrub and clearing, water courses, and season — chiefly insofar as season affects rainfall and food supply. These factors are indicated where known.

Opossum

Didelphis marsupialis etensis

The Eten Opossum is easily recognized, as it looks, at first glance, like the Virginia Opossum. It differs from the northern form in many characteristics, having, for instance, seven mammae, but like that opossum, two color phases of this species occupy the same territory.

It is nocturnal. In looks, intelligence and some few habits, the two species are much alike, but the gait of the Eten Opossum is more rapid. Also, only a few individuals will "play 'possum," while most are willing, savage fighters. Full grown males, some of which weigh 2.1 kilos, can put up a very effective defense. One such individual was taken in a live trap, a hind leg snared, and then removed from the trap. He repeatedly charged the man holding the rope. He was then grasped by the scruff of the neck and lifted from the ground, and, still fighting, was carried into the laboratory where an ether cone was applied while the animal was held on the floor. In his attempts to escape the cone and the grip on his neck, he pulled out all of the nails on his forepaws. In addition to the four feet, the teeth are used for holding to a vine or similar object when an attempt to dislodge them is made.

Not only are they willing fighters, but they move much more rapidly than the Virginia Opossum. Individuals that have not been exhausted by struggling in a steel trap may be quiet for a moment after being released, but soon dash off at a very rapid gait. In no case was the writer able to catch up to and pick up a fully grown individual as he has done with the Virginia Opossum — partly because of the speed, partly on account of the very active defense with which the retreat is covered when the pursuer comes close enough to touch them. They run well, climb well, and are very much at home among the many tropical vines.

Everywhere the writer worked, *Didelphis* was the most abundant opossum. That this is not always the case is evident from a statement by Goldman: "While this form may be said to be abundant, it occurs in smaller numbers at most localities than *Metachirops opossum fusco-griseus*." (1920, p. 46.) They were seen frequently at night by aid of a hunting lamp and were easily trapped. As many as four would be seen about the clearing in an evening, and as many as three adults have been observed feeding in a single tree. They are most numerous along wooded streams and in the forest, but many are seen along the roads running through the Cattle pastures of the Canal department of Cattle Industry as well as about houses in town.

Didelphis came to the clearing to feed on pineapple, guava, papaya, banana, and Star-apple, to all of which fruits it did considerable damage. Mangoes and figs are other foods. In captivity, they thrive on these fruits with the addition of the carcasses of rodents and flesh of any mammal, or birds and eggs, as well as insects. In the wild, they doubtless eat insects and everything small enough to overpower.

Crabs form a substantial portion of their diet, at least near seacoasts. (Goldman, 1920, p. 46.)

Females with two, five, and seven pouch young were taken in March, May, and August. Seven is the maximum number that can survive birth as there are but that many mammae. The young are practically indistinguishable from those of *D. virginiana*. A female captured March 4 had seven very small pouch young. It was April 14 before they came out of the pouch. Ten days later the young still entered the pouch to nurse and sleep, but it was not until April 27 that they were observed to eat, the food being figs. By this time they were large enough to hiss when handled and were very active, but returned to the mother from time to time. May 7, they were as large as some specimens that entered traps and were rather independent of the female although they slept in a cluster with her or near her.

There appears to be little understanding of the use of the tail, for opossums are mounted and drawn as hanging by this member, the extreme tip of which is wrapped tightly around a small twig. This the writer has never observed. A captive specimen showed remarkable strength when the tip encountered a strand of wire, but usually the grip of the tail around small twigs and vines is not very strong. However, the tail is invaluable to this Opossum as it is to *Marmosa* and many other prehensile-tailed mammals as a safety device. While treading its aerial highways, the tail is loosely curled around the limb or vine along which the animal is passing, and it can be clamped around a support with telling effect if the limb is shaken. Should the animal lose its footing the tail does much to prevent a fall. The "hands" of *Didelphis* make it very sure-footed on small vines, but less so on larger vines and limbs, and it is here that the tail is used most effectively. The writer has never seen this marsupial use the tail as a brace in sitting, or seen it assume the "tripod" attitude.

This mammal is a good swimmer: one individual when struck at dived under the water, swimming vigorously and rapidly.

Canal employees and natives alike rise up at the mention of the opossum to assure one of its deadly raids upon domestic poultry aud on the game birds. The writer observed such a raid at Alhajuela. A medium-sized opossum took a month-old chick away from a hen at 5.30 A.M. The native to whom the chicken belonged said that the opossums were a source of constant loss. Nevertheless, he permitted the hens with chicks to spend the night under the floor of a shed in a situation which invited attack by all flesh-eaters, including rats of which there were many. The usual method of "housing" chickens

is to erect a few poles on uprights about six feet above the ground and trust that no opossums, owls, Tayra, or cats are hungry enough to eat them.

It is the writer's belief that these attacks are greatly exaggerated. If the members of this group are such blood-thirsty poultry- and bird-killers, why did a crippled "pavo" remain undisturbed on her nightly roost which was not more than eighteen inches above the ground when many *Didelphis* were seen about? She roosted unmolested from March 10 to July 3. True, there was much fruit available at this time, but the very type of poultry roost used rather discredits any great propensity for killing on the part of the rather stupid opossum.

The opossum makes a nuisance of itself about houses by climbing the vines usually grown to shade the screens, thus making considerable noise. It is probable that these excursions are made in search of insects that have been attracted by the lights or that have collected upon the screen. Trips are made to balsa flowers apparently to eat insects usually found there. Specimens were observed passing the day among the dry fronds of a palm and in dense growths of vines as well as in cavities under houses, so there is no lack of hiding places in towns. One individual built a nest of leaves on the lath roof of the greenhouse at Summit. Here it did considerable damage by eating seed, pulling up seedlings and tender plants.

Ticks are abundant on some individuals and nematodes are found in many. One individual carried a bot, Dermatobia, on the front leg. A large individual had furnished a meal for a Boa, as was discovered when the snake regurgitated it upon capture.

The pectoral gland, located under the yellow spot on the chest, secretes a yellowish, clear, fatty liquid which comes in contact with objects up which *Didelphis* climbs. The anal glands secrete a fatty, white solid which is thrown off when the animal is irritated. The secretions of the anal glands are much the more offensive to the nose.

Isthmian Marmosa

Marmosa isthmica

This opossum is the smallest marsupial found on the Island. The males are the size of a laboratory rat, while the females are very much smaller. Males average about 15 inches total length, of which the tail is 8; females, average total length — 12½ inches, tail, 7. Large males weigh 954 mg., and females, 660 mg. On seeing a female of average size one appreciates the name sometimes given

to the group — Murine Opossums — for they are not much larger than some species of mice. The species may be distinguished from the rodents by the large mouth which can be opened widely, many teeth — the incisors small and pointed — naked ears, prehensile tail, and the feet with five distinct toes — the "thumb" on the hind foot being somewhat opposable. The general color is brownish cinnamon above, passing from ochraceous on the sides to cream buff on the belly. The large eyes are another distinguishing characteristic. There is no marsupium. The type was taken at Rio Indio, near Gatun, by Goldman.

Most of the Marmosa taken were captured alive, so little could be learned about their food by an analysis of stomach contents. Caged specimens eat a wide variety of foods including items they would not find in the forest. Thus raisins, cheese, bread and milk are favorite foods, although they thrive without them. Hudson's statement, made after observing specimens of *M. zeledoni* obtained from a fruit store in Lincoln, Nebraska, that "they lean strongly toward the insectivorous habit and capture live insects with great gusto" (1930, p. 159) is a good summary of their food habits. He states that they ate bananas, peaches, grapes, bat carcasses, viscera of mice and birds, and earth worms, as well as moths and grasshoppers. Caged specimens in Panama ate, in addition to the exotic foods listed, bananas, papaya, pineapple, star-apple, figs, mangoes, the curled tip of the espavé bean, and other soft fruits. Upon such a diet they would live for some time but finally would weaken and die. One night an individual was observed to climb down to the edge of the clearing, stalk a large green grasshopper, pounce upon the insect, kill it by crushing the head and thorax, then retreat to the cover of the tangle to devour its catch. All this was done under the glare of a powerful light which did not appear to disconcert the hunter. This episode resulted in experimentation with the caged animals. They caught and ate grasshoppers of all kinds, one female eating five large ones in half an hour late one afternoon. In passing, it may be observed that she retired to her nest to sleep and had not stirred out of it up to eleven o'clock that night. Nevertheless, she was ready for more next morning! The large grasshoppers are killed by a series of crushing bites about the head and thorax and only the harder parts and lower portions of the legs are discarded. It is an amusing sight to watch a tiny opossum sitting on its haunches eagerly devouring a large leg, strongly resembling a child with a "drum stick."

One might suggest that since grasshoppers are not nocturnal,

Marmosa would not eat many of them under natural conditions. The writer is by no means familiar with insects, but has observed many large grasshoppers at night. Moreover, many of these insects are captured in traps set for Marmosa! So their ranges must meet somewhere. In addition to grasshoppers, stingless bees that were attracted to the cages by the discarded food were captured and eaten. When given a papaya stem that contained termites a female ate them by licking up those that had been exposed when a strip was pulled off. Unlike the anteaters, the White-face, or Titi Monkeys, she made no attempt to pull apart the stem to uncover other termites. This is to be expected, for Marmosa is small and weak.

After the introduction of insects into the diet, the animals remained in much better condition. Cheese made a good substitute for insects. Salted nuts were always accepted, the salt licked off and the nuts discarded. The craving for salt may have been the result of too much fruit in the diet, for these were captive animals. While no offal from mice was eaten, animals that died were partially eaten if not removed at once. It is possible that one death was the result of an attack by a cage mate; whether or not the object was to eat the victim, the fact remains that it was partially eaten. Kraatz (1930, p. 288) reports finding parts of two young eaten, probably by the captive mother. Insects are preferred to flesh, but it is probable that under certain conditions of food or confinement flesh is eaten. All of the figs on the Island are badly infested with larvae of various insects. Marmosa is partial to very ripe figs, eating the inner pulp, seeds, larvae and all.

Like the other opossums, Marmosa is a solitary animal. More than one adult was never observed occupying the same nest, nor were they observed hunting together. When in captivity they lived together peaceably, as many as five occupying the same nest cavity. Weak ones were attacked however, and partially eaten. They will fight furiously over food placed in the cage unless it is so divided that each can carry a portion to a corner to eat alone. Even then fights may occur if the weight of the food is not great enough to require all their strength to carry it. Two females removed from traps and placed together sprang at each other at once. However, they usually live together peaceably, even though several adult males and females are placed together.

In spite of the small size and feeble dentition of the animal, Marmosa is a ready fighter. Two females that had been kept together for several weeks were peaceable until food was placed in the cage. On one occasion, two grasshoppers were presented to them. The first

one to receive a grasshopper grasped it in her forepaws, promptly bit it through the back of the head, took it in her left paw, and immediately started after the other grasshopper which had been, in the meantime, captured by her cage mate. She did not seem to be noticeably handicapped in her attack by the fact that she was running on three legs with the grasshopper clutched in the fourth. The other Marmosa upon being thus approached instantly assumed the fighting posture. Grasshopper firmly held between her teeth, head up, forepaws raised in striking position, and balancing herself on her hind legs with the tail as a brace, she met the onslaught. In the ensuing melee both grasshoppers were forgotten as the Marmosa took up the fight in earnest, rolling around on the bottom of the cage, biting and hissing. It was with great difficulty that they were separated, and both showed an eager willingness to resume the combat, for when one was picked up by the tail, instead of turning to bite the hand, she devoted all her attention to holding her opponent, finally lifting her off the floor by the strength of the grip of one front paw on the fur of the rump of the other female. They had to be placed in individual cages for their safety.

The adults are no more aggressive nor willing to stage an active difference than the young. Two half-grown Marmosa were placed in a cage with a Spiny Rat, where they settled down in one corner taking no notice of the other inmate. However, when food was placed in the cage and the octodont approached the feeding Marmosa, one of them sprang at the intruder with open mouth, hissing venomously. The attack was directed at the head and with such speed that it could not be determined whether the rat was actually bitten or merely struck, but it was sufficiently effective to drive back the aggressor and keep him at a distance, despite the fact that he was many times the size of the half-grown Marmosa.

The same remarkable courage is shown whenever Marmosa is approached. How effective this method of defense is cannot be determined, but it is certain that it is not mere bluff, for most individuals will bite if pressed. After assuming this defensive posture they will sneak off if not further molested. At no time was a Marmosa observed "playing 'possum," nor could individuals be induced to do so, always showing instead remarkable ferocity for an animal so small. Marmosa is no more intelligent than the other opossums.

Marmosa hole up where daylight overtakes them. In an attempt to study the nesting habits of certain birds, a large number of bird boxes were put up around the edge of the clearing and through the

forest. These boxes were made of a cylinder of roofing paper capped, top and bottom, with metal, and suspended by means of wire. One day Donato drew attention to the presence of a Marmosa in one of these nest boxes; after this experience these boxes were examined regularly, and others, more suited to Marmosa, were placed in the plantation. Thus an opportunity to study the nesting habits was offered.

One nest box in particular appeared to be a favorite. It hung about seven feet above the ground in a small tree, one of a dense stand a few feet from the edge of the clearing. When first observed, the box contained a nest of dry leaves and was occupied by a young female. It was twenty-five days before she was seen again in this nest. In the interim, no less than three individuals used the same box. Each individual first dragged in some dry leaves to form a nest, for whenever the box had been found unoccupied, the leaves were removed. None of the "visitors" stayed long. The daily observations may have disturbed them even though they were made with as little commotion as possible. In another box some fifty yards away where observations were made irregularly and the nesting material left undisturbed, the same transient occupation was observed. In none of the boxes located in deep forest were signs of use by Marmosa discovered.

Abandoned bird nests are used in the same manner by Marmosa. One specimen was taken from the nest of a Mexican banana quit (*Coereba mexicana mexicana*), and feces of Marmosa were found in several nests including that of a mannikin. These nests were occupied irregularly as were the nest boxes. Although they are reported in cavities and hollows in the forest, no such nests were found that could be assigned without qualification to Marmosa.

In banana plantations there are many nesting sites. The young curled leaves, the bases of mature leaves both living and dead, as well as the cavities under the hands of the developing bananas all offer excellent sites for nests. Strips of dry banana leaves are carried into such nesting places as may be seen upon examining the trees and stems. It is this habit that accounts, at least in part, for the animals that reach this country as stowaways on the banana ships.

In sleeping, the typical rodent position may be assumed, or the animal may lie curled up on its side. If in an exposed position, the animal crawls under the litter to sleep; in cans or nest boxes, it curls up on the nesting material. Like the other opossums, Marmosa is a deep sleeper, allowing a very close approach and sometimes con-

siderable disturbance of the cage before awakening. If the animal does not see the cause of the disturbance, it may either cower where it is or attempt to sneak off, but if a hand is nearby, the defensive attitude is assumed at once.

No one can estimate the home range of the animal. Because it is a slow mover, whether on the ground or among the tangle, which is preferred, any great individual range would not be expected. However, clearings and "blow downs" are some distance apart, but all that were consistently examined showed the presence of the opossum. A shifting food supply must force individuals to wander considerable distances. The day is spent in any suitable spot where daylight overtakes them; there appears to be no fixed abode. This would aid them in covering considerable territory, even though the rambles of one night would not take one far from the resting place of the previous day. Movements that cannot be accomplished by speed can thus be achieved by persistence and mobility of domicile. Two individuals, both adult males, were captured about four hundred yards away from suitable cover.

During the first trip made by the writer, several types of traps were employed to capture animals. Specimens were taken in rat traps, Schuyler traps, spring-floor rat traps, and homemade live traps that were set on stumps, on vines, and on and under logs, and on the innumerable trails through the dense growth. Naturally, many other mammals were taken in addition to Marmosa. The live traps were most effective, so on the next trip only spring-floor rat traps and a dozen small Sherman traps were used. The spring-floor traps were set as they were the first year, while the Sherman traps were tied to small vines, branches and so on. One of the most striking demonstrations of the great difference in weight between the two sexes was encountered here, for it was possible to set a spring-floor trap "hard" enough to catch males only, or animals of similar weight, while females or immature males and mice were the only specimens small enough to enter the Sherman trap. Thus, if bait was eaten out of a spring-floor, a Sherman trap was introduced into it, the "hardness" of the set was increased, and the trapper was usually rewarded by the capture of a female. Similarly, if a Sherman trap, located out of the reach of *Didelphis* or Coati, had been disturbed, a spring-floor trap would usually capture a male. This is not to be interpreted to signify that the females cannot be taken in the spring-floor trap, but that, for practical convenience in setting, the spring-floor was coarsely adjusted to the weight of a heavier animal. The third season again

demonstrated the superiority of live traps that could be tied to vines and branches. In fact very little use was made of any other style.

The most productive bait was the universally liked banana. Papaya and mango were also excellent. The usual rolled oats, and combination of rolled oats, raisins, peanut butter, and bacon fat were tried but attracted nothing save ants. Nuts were no better except that ants do not disturb them, nor do they sour in the damp warm atmosphere. Live grasshoppers tied in the traps by passing thread around the thorax were tried but they were not effective. Bait is not necessary when using Schuyler or rat traps placed on logs or trails as the animal is not wary and steps on anything in its way.

The enemies of Marmosa must be legion, for it is small and although valiant in defense, it is relatively weak. For safety, it must depend upon the dense tangle through which it moves slowly but securely, for a heavier animal cannot follow on the slender, flexible vines, nor can an enemy in the air attack it under such circumstances. The only hawk likely to prey upon this little opossum is the White-throated Bat Falcon which was seen hunting over the clearing many times, but no evidence of any kind was secured to indicate that it did secure any individuals. The falcon is, however, large and strong enough to feed upon Marmosa. Several of the owls might be listed as possible enemies, but the animals do not appear to fear attack from the air for about the plantation, Marmosa traveled along the tops of banana leaves in a manner that exposed it to any attack from the air. Progress under these conditious was very slow and quite noisy.

Tate (1933, p. 126) quoting a communication from G. M. Allen says: "Fragments of jaws referable to this species and others, apparently of *Philander*, have been discovered in the casts of the owl *Pulsatrix* on Barro Colorado Island in Gatun Lake, Canal Zone."

Any carnivor or omnivor large enough to overcome Marmosa must be listed as an enemy. *Didelphis* is included here, for one individual broke into a cage containing a Marmosa where it was found next morning along with the remains of the original occupant. Coati visited the cages where specimens were kept and were seen attempting to enter some of them. One Coati succeeded in opening a cage, so the cages were moved into an enclosure. Coati were seen attempting to secure Marmosa captured in live traps, and many of the live traps broken into showed the marks of Coati. Coati, therefore, is listed as a great enemy, possibly the worst.

While traveling along the small trails, or over the ground in the plantation, Marmosa must be exposed to many hazards. As the

small trails traversing the shrubby thickets are used by many mammals, some much larger than Marmosa, it would be surprising if some did not meet their fate in this manner. In one pellet of Ocelot dung was found hair that may have been that of Marmosa.

Many individuals taken were infested with *Porocephalus sp.*, according to E. W. Price of the Bureau of Animal Industry who kindly identified them. These are immature, and occur in the mesentery, under the diaphragm, and in the liver and lungs, as well as in the abdominal and thoracic cavities. One specimen died two days after capture; the liver and lungs were heavily infested and the arch of the diaphragm inclosed many. This was the heaviest infestation noted. No individual examined was suffering from bot-fly infestation.

Marmosa can be said to be strictly nocturnal not crepuscular. They begin their nightly search for food after dark. Specimens were never seen nor removed from traps before 7.00 P. M., nor do they appear to be at large toward the end of the night. This statement is based upon the fact that Marmosa were generally removed from the traps on the round made from seven to eight, and those caught in snap traps not visited were badly decomposed by morning. By 8.30, many of them are moving about, hungry cage specimens becoming active even before this hour. On the other hand, during rainy weather specimens were found in the nest boxes still resting at this hour. The greatest activity of Marmosa in the plantation appears to take place during moonlight nights. Most of the specimens observed under these conditions were males. Well fed animals do not come out until much later and retire again as soon as they have eaten. However, they are not so strictly nocturnal but that they will eat during the daytime if hungry or particularly choice food is offered. Apparently they suffer considerably when exposed to a bright light for their eyes water, a film may appear over them, and the animal assumes a general attitude of dejection.

Marmosa is most at home among the small trees and vines to which its feet are so well adapted. Its most rapid progress is made along vines or branches up to half an inch in diameter. These it grasps readily, using the semi-opposable thumb of the hind foot with great effect. Except when climbing perpendicularly, the tail is always carried curved loosely around the limb. When an intersecting branch or vine is encountered, the tail is uncurled in order to go by it, but immediately encircles the support when the obstacle has been passed. Thus the tail while useful as a safety device does not play an important role in locomotion. However following etherization, control of

the tail is regained before the use of the limbs, the animal being able to hang by its tail before it is able to hold on with all four feet. On the ground Marmosa moves as do the other opossums, and can be hurried into a gallop if pressed. None of its motions are very rapid and it is very easily overtaken.

When Marmosa reaches a gap it may attempt to leap across it; the distance covered by such a leap depends largely on the position from which the animal makes the leap, as well as the type of footing afforded. Thus, in passing from one banana tree to another, the longest leap observed was approximately seven inches. Considering the flexibility and smoothness of the tip of a banana leaf, this is more difficult than a much longer leap from more secure footing. In making such a leap the animal sails through the air with legs outstretched. One female hanging perpendicularly to a small, smooth-barked tree attempted to leap to another which was seventeen inches away. Although she reached it, she missed her hold as she had not jumped far enough. This might have been due to her hurry in attempting to escape, to the bright light, or to the smoothness of the bark which offered a very poor footing. The longest jumps are made from a place where they can assume their typical jumping position. The tail is placed straight behind and used as a brace, the hind legs placed well apart, resting upon the entire foot up to the crus, the front feet are placed between the hind legs, the back is arched. First, the front feet are raised with the anterior portion of the body, and then the back is straightened with the hind legs supplying much of the impulse to carry the body forward. In moving through the tangle, no leaps were measured, but it was observed that if the front feet reached the objective the animal was able to clamber onto it. If at this crucial point, the perch is shaken, it is grasped with the teeth as well as the forepaws until the hind feet and tail can secure a purchase.

Of all the natives to whom live Marmosa were shown, only four or five recognized them as having been seen before and only two recognized them as opossums. No native name was applied to the specimen excepting the very general term "raton" or rat. From this one might infer that it is a rare animal. This is not the case for it is abundant. Being nocturnal, a shy and inoffensive creature, and of no use as food nor a threat to man's poultry or produce, it is not hunted. Those unfortunates that are discovered in clearing brush, or cutting bananas are killed at once as rats for which they are mistaken.

However, men who work on the barges buying bananas along the shores of Gatun Lake, say the "banana rats" are common at times. As they fail to distinguish between Marmosa and rats, as well as two other genera of marsupials, it is doubtful whether their estimates are accurate. Mr. W. H. Babbitt, who has had a great deal of experience in Panama, assures me that he has seen as many as six in one barge load of bananas. This is accurate for Mr. Babbitt was familiar with the species and its habits. In fact, he was the only person who was able to trap any specimens. All who are familiar with Marmosa refer to this apparent abundance at times and its rarity at others.

This checks with the experience on Barro Colorado Island, at Summit, and Alhajuela. Thus Marmosa was so frequently trapped during June and July, 1929, that it was considered to be one of the two most abundant mammals on the Island. During this period eight were captured. As no special pains were taken to secure this species the number was more indicative of the general population than later figures when Marmosa was the chief object of an intensive search. More than forty were taken between November 13, 1930, and February 18, 1931 — twenty-four being trapped alive during the first two weeks of February! Six were captured between February 28 and March 8, 1932, but no more until April 6 when a single male was captured, then another on May 19. No more were seen before leaving July 2, nor were any secured from the banana buyers who had been interested in the middle of June.

What factors operate to explain these changes? Are they changes in population, or just a shift in range? There are four possible explanations. The species may have been:

1. Trapped to the point of extinction
2. Reduced by an epizootic or by parasites
3. Changed habitat with the breeding season
4. Changed food and feeding grounds

That they were not trapped to the point of extinction is clearly indicated by results of the trapping in February, 1931, when trapping was discontinued while the animals were abundant, coupled with the fact that when trapping was resumed in February, 1932, many were taken during the first week or so. Moreover, even though they did not enter the traps some individuals were observed.

Although Marmosa suffers from some ecto-parasites and endo-parasites to the extent that some die of the infestation, neither parasites nor an epizootic would explain the sudden absence from traps

without the discovery of at least one or two very much weakened or dead animals.

There is a possibility that there is a change in habit with the breeding season for none of the females taken were pregnant. Moreover, the Marmosa reported from the United States, which they reached as stowaways in bunches of bananas, are mostly females with young. Later a discussion of this will be given. It is mentioned here to indicate that, possibly, pregnant females retire to cavities, hollow trees, and so forth, until the young are born. This would not account for the change affecting the males.

The change in food and feeding grounds appears to be the real explanation of the apparent fluctuation in numbers. Toward the end of the dry season succulent foods and fruits are scarce in the forest and many of the insects upon which Marmosa feeds decrease in numbers. This concentrates the animals along the clearings where the grasshoppers abound and where there are discarded papaya and bunches of bananas upon which to feed. At the same time the scarcity of food leads them to enter traps baited with the fruit they cannot secure in the forest. During such a period, eighteen were caught in four days. With the ending of the dry season many fruits ripen and the bait offered is no attraction. Hence few specimens can be captured until with the advancing rainy season, another period of scarcity arrives, and the hungry animals again enter the traps.

Considering the fact that most of these animals were taken about a clearing but a few acres in area, the writer is convinced that Marmosa is a common mammal in suitable habitats on Barro Colorado Island, even though an accurate means of estimating its numbers is not at hand.

By far the largest numbers were found in the intricate interlacing of vine and branch that characterizes the second growth which abounds around the edges of clearings. Here are the pathways to which the feet of Marmosa are so well adapted. Here the growth is so dense that large enemies can be eluded; here abound many of the insects that form the important part of the food supply; and here is afforded a base for sallies into the clearing. Traps placed on small trees, stumps, branches and vines captured many specimens and many were observed hunting for grasshoppers and katydids along the edge of the tangle and on the ground.

Marmosa is not an animal of the deep tropical forest as much as a dweller along the edges of clearings, in plantations where cultivation

is not too clean, and in "blow downs." Few individuals were seen or trapped more than twenty feet above the ground; those that were seen were only in the deeper forest. Indeed, their feet are not too well adapted to climbing large trees nor are they able to move rapidly along large limbs. Their method of locomotion and feeding habits are much better fitted to second growth forest, lower tangles, and banana plantations.

One might ask where such an animal found this type of habitat in the original forest. Many of the trees are shallow rooted and are bound to each other by strong lianas and vines. The accumulation of weight must place a serious strain on the roots. When the soil is softened by rains, an extra strain put on the roots by the pressure exerted by high winds, or through the weakening of a tree by decay, widespread destruction may occur. In such circumstances a tree does not fall alone but carries with it many neighbors. Thus the destruction may spread over an acre or even more. Here among the tangle of trunks, branches and vines is an ideal hunting ground for the small opossums. It is in such places in the forest where Marmosa were taken.

Plantations, chiefly banana plantations, offer another environment where Marmosa occur. They were found living in banana trees, as one would suspect from their frequent occurrence in bunches of bananas. Bananas are planted some distance apart so that, as a rule, Marmosa must descend to the ground to pass from tree to tree. Where the plants were close enough together, individuals were observed passing from one to the other by dropping from a higher leaf to a lower leaf on the neighboring tree. Marmosa occupy other types of plantations such as papaya, citrus, and mango. While by no means an ideal habitat for Marmosa, numbers of them are found in plantations.

Every year there are several reports of Marmosa of various species being imported in stems of bananas (Shanafelt, 1927; Preble, 1926; Kraatz, 1930; Potter, 1930; Warren, 1928; Wagner, 1928; Adams, 1928; Enders, 1930; Hudson, 1932). When, in its natural haunts, a ripening stalk of bananas has been selected as a retreat, the story is not difficult to reconstruct. When the cutter comes along he cuts the tree so that the stalk is gently lowered and the bunch of bananas is grasped by the carrier before the final cut severing the stalk is made. This would disturb, but might not alarm, an animal within. Doubtless, many flee at this point or escape while the stalks are in the banana barge or on the train. Once delivered into the hold of a ship there

would be little likelihood of finding any better hiding place. The bananas are quite green when placed in the hold and are, therefore, unfit for food for Marmosa. Among the stalks and packing are numbers of insects of many kinds — spiders, tarantulas, roaches, and others. The problem of food may be solved by eating insects. Some ships refrigerate their holds and others do not. Aside from the matter of temperature, the conditions in the holds are very similar. Because ripening bananas consume much oxygen, a constant stream of fresh air is forced into the hold. In either case the stream of air enters unchilled, so conditions near the entrance are approximately the same.

The holds of refrigerated ships are held at temperatures ranging from 57° to 52°. It has been suggested (Wade, 1930, p. 365–366) that 57° "approaches very closely the ideal hibernating temperature of mammals exhibiting this phenomenon," and as the capacity for temperature regulation is imperfect for certain of the lower mammals, he asks, "Might it not be possible that these small opossums of the genus Marmosa, kept in a subnormal temperature, were unable to maintain their body temperature and became lethargic or partially so with the consequent reduction of metabolic activities? Under such conditions no food taking would occur and with the metabolic rate greatly lowered the animals could survive extended periods of adversity. This would be still more plausible for the immature individuals as the young of many mammals do not have the regulation of body temperature well established at first."

Wade wrote this after reading a paper (Enders, 1930, p. 438–439) in which the writer speculated concerning the food of the animals while in transit. Since publishing the above note the writer has learned more about the food habits of the opossum as well as the conditions existing on banana ships.

In refrigerated ships, while the temperature of the hold may be held as low as 52° F, a constant stream of air is forced into it. This air is not pre-cooled, but passes into the hold directly from the intakes on the upper deck, thus being, at least for many months of the year, warmer than the air in the hold. To this incoming flood of fresh, warm air come many of the insects that were sealed in the hold with the bananas. This concentration of insects is so great that it is recognized by the engineers in charge of refrigeration and is usually explained by stating that the concentration of carbon dioxide in the hold is so great that they would die if they did not seek the incoming, oxygen-bearing air stream. Regardless of the explanation offered, the engineers agree on the fact of concentration.

Such a condition is ideal for Marmosa. It is a nocturnal animal with a well developed ability for securing insects at night, and is highly insectivorous. Moreover, it too, would seek the warmer portion of the hold and thus come in contact with the insects instead of being compelled to hunt them among the cargo. It is easy to picture the events in such a case. When the hold was opened the Marmosa would retire to a stalk of bananas and the handling experienced in Central America would be repeated.

Examination of the reports of Marmosa stowaways reveals the fact that the majority are females with young. How can this be explained? In the first place males are much larger, so might be discovered before the stalk was transported very far. However, larger genera of marsupials including Metachirus, have been reported. Males might, too, be more inclined to leave a hiding place when disturbed than would a pregnant female, or a female with newborn young. Nor must one overlook the fact that the "banana rat" would be killed and tossed aside with but little interest unless young were found with her. As has been said elsewhere, it is very possible the pregnant females seek out some retreat and stay in it or very nearby until the young are large enough to venture out with her. Stalks of bananas would serve very well for a nursery which would explain the preponderance of females with young.

It was chiefly with reproduction in Marmosa that the writer was concerned during two visits to Panama, but very little was learned. In the first place, there were only two records of young individuals that could be definitely assigned to the Canal Zone species. The difficulties of identification of species and port of origin made the records from stowaways of doubtful value. During one summer the writer had taken juveniles and lactating females. It was thought that in the absence of breeding records of the tropical opossums, breeding might take place at any season, as appears to be true of *Didelphis marsupialis*. So trapping was inaugurated in November. Thus from November 13 to February 19 more than forty were taken; from June 24 to August 3 of another year, ten; and from February 24 to April 6, eight were captured. Not one female was pregnant! Histological sections of many ovaries disclose nothing but the dioestrum condition. Juveniles were trapped on May 19, June 24 and July 12, and a sub-adult, August 3. All of the others were adult. Of these, one taken July 12 was lactating.

Among the records of banana stowaways, not all of them satisfactorily determined as to species, young are reported in March

(Enders, 1930, p. 483), June 14 (Kraatz, 1930, p. 288), and August (Warren, 1928, p. 422). From the last report one would judge that the young were about ready to assume an independent existence. These dates check with the experience of the writer in the field, and lead to the conclusion that Marmosa breeds but once a year, probably in late February and March. It follows that the young born one spring do not breed until the next year for which conclusion there is much support to be derived from the histological study of the reproductive systems of many females.

There is some variation in the number of mammae. Bresslau's table states that there are from nine to fifteen in *M. murina;* nine to eleven in *M. cinerea;* while the writer found that in *M. isthmica* the number was usually thirteen. The mammary area is approximately 2 cm. wide and 3 cm. long, six mammae being arranged in something of an arc on each side with one in the middle of the area. Hence regardless of the number of young born, only thirteen could secure attachment and thus survive. How many are born is not known, but within the genus, the number of young reported runs from "nearly a dozen" (Kraatz, 1930, p. 288) to ten (Hill and Frazer, 1929, p. 191), nine (Potter, 1930, p. 91), six (Shanafelt, 1927, p. 103) (Hudson, 1932, p. 159); on down to one (Warren, 1928, p. 422). In the field the single female with young had two young, but as they were large enough to be independent of her the others may have left her when she was trapped.

No reports of young at birth or shortly after birth are on record. Judging from other marsupials of the same family, it is supposed that they are born after a short gestation, are small, naked, helpless, and that they seek the mammae and become attached as do the young of marsupials having pouches. The smallest young observed by the writer had a body length of approximately 22 mm. They were firmly attached to the mammae, or so it appeared, fully covered with hair which differed from the adult condition only in being darker and softer; the eyelids were incompletely formed as was the mouth. Nevertheless, the mother freed herself from them, leaving them in the nest when she went foraging. This same habit of leaving the young in a nest while the mother hunted may explain a case encountered during field work. A lactating female was captured in a live trap and two quarter grown young taken thirty-six hours later. When placed together, the young clung to the female and she was very active in defending them. Moreover, she permitted them to take food away from her, an action difficult to explain on any basis

other than that she was their mother. The young may cling to the female after she has been killed, Hudson (1932, p. 159) reporting the finding of a recently killed female that "had six living young attached to her mammae and fur."

"Daubenton . . . gives a short account of the genital organs of another Didelphyd under the name of 'la Marmose', which Mr. Hinton has been good enough to determine for us as *Marmosa murina*. The female had ten attached pouch-young, four lines in length, four vacant nipples, and no pouch, though two slight lateral folds bounded the mammary area." (Hill and Frazer, 1925, pp. 190–191.) In *M. isthmica*, as has been said before, there are but thirteen mammae, and no indication of folds bounding the mammary area has been found even by a study of the abdominal musculature. This illustration is of importance, in spite of the rather unnatural pose of the female, in showing the method of attachment of the young.

Many more observations of young that have passed the stage where they cling to the mammae are on record. "Nearly a dozen young were clinging to the mother . . . The young clung with claws almost anywhere on the fur, but principally ventrally, and occasionally on the tail. A few times one of the young wandered off a few inches. When I approached it closely, the mother would grasp it with the claws of one foot and speedily thrust it under her," says Kraatz (1930, p. 288), speaking of *Marmosa* — either *isthmica* or *zeledoni*. Potter (1930, p. 91) in speaking of the genus says: "All nine are carried on the back and sides of the mother. They cling to the fur with their mouths and feet and occasionally are aided by the prehensile tail. The mother was seen to toss the young from the floor to her back with her nose, and the young grasp the fur on her back upon alighting."

Still later in development the young, when disturbed, grasp the fur of the female with tooth and claw. At this stage they are about three-fifths grown and are able to survive independently.

The statement is made frequently that the young become attached to the mammae from which, without effort on their part, milk is "pumped" into their mouths by the action of the muscle of the mammary gland. This action is variously ascribed to the cremaster "ilio-marsupialis" or panniculus carnosus. In passing, it may be said that such an action is more than problematical and the matter will be taken up in a paper on the ventral musculature of the Didelphid marsupials.

Allen's Opossum

Metachirops opossum fuscogriseus

This opossum is of medium size, the pelage short with no bristles projecting through the fur which is unlike the long woolly pelage so characteristic of the philander. In size it is similar to the Brown Opossum but differs from it in its general grayish coloration, the eye spots being very light.

No specimens of this species were taken on the Island but one was observed high up on a limb on Zetek Trail under the rays of a hunting lamp. They are not common on the Island for while they enter traps without hesitation none were taken; but many were captured at Alhajuela in habitats similar to those on the Island, and J. B. Shropshire's men sent the writer numbers of them from the Zone. Why they are not abundant on the Island is a puzzle.

Next to the Brown Opossum, this is the fiercest fighter of the opossums studied. Allen's Opossum is ready to fight at all times and no amount of handling appears to diminish its resentment. Goldman (1920, p. 52) found that they fought savagely when taken in steel traps; to this the writer can add that they fight the same way whenever touched. However, they are a bit more tractable than the Brown Opossum.

These opossums, too, are accused of being poultry- and bird-killers, and Goldman's observations bear out this fact. In captivity they were more carnivorous than any of the other opossums observed. They ate meat of all kinds including ant-eater, carcasses of rodents, grasshoppers, and eggs in preference to any kind of fruit, although they did eat banana, papaya, pineapple, and figs. One hungry individual, while fearful of the hand offering a ripe banana, nevertheless sniffed from a safe distance while saliva dripped from its jaws.

Goldman (1920, p. 52) says of this opossum's nesting habits: "A nest of one of these opossums was found three feet from the ground on a fallen log. The log lay in the dense thicket of an old clearing and was heavily overhung with vines and bushes. The nest, globular in form and about a foot in diameter, was placed in a well-hidden spot among the vines. It was made entirely of the banana-like leaves of a native plant rather neatly laid together. The opening at one end faced outward along the log. The occupant slipped quietly out of the nest, when I was within three feet, ran rapidly along the log and disappeared in the thick vegetation. The nest cavity was

clean and about the size of the animal's body." In captivity they lined the nest boxes with dry banana leaves furnished for the purpose.

While a good climber, *Metachirops* was usually encountered upon the ground, on or under logs. It is probably more terrestrial in habit than any of the other opossums studied excepting possibly *Didelphis*. This might be surmised from its build, which is well adapted to terrestrial locomotion.

Five is the largest number possible in a litter that can survive, as there are but five mammae. The mammae are located two on each side and one in the middle. The pouch is not as well developed as in *Didelphis*. Non-breeding females were taken from January to April. After that date until July, females with litters outnumber the others; litters of two, four, and five were observed. As pointed out by Goldman (1920, p. 52), the young do not seem to cling as closely to the teats as similar young of *Didelphis*. Although only comparison at birth would establish the fact, apparently they are more mature at a given age than *Didelphis*.

The type of this species was discovered in a bunch of bananas in unloading a steamer from a Central American port (Allen, 1900, p. 194)

Brown Opossum

Metachirus nudicaudatus dentaneus

Although the Brown Opossum has been seen several times on the Island, it has never been taken. Thus, Dr. Barbour and Dr. Chapman saw one climb a balsa tree and go to a flower, and Dr. A. Skutch saw one in a tree by the tower. The numbers sent to the Island by Mr. Shropshire's men were considerably less than Allen's Opossum. However, several were seen near Las Cascades hunting at night.

The outstanding characteristic of this medium-sized opossum is its savageness. In attitude as well as disposition it reminds an observer of a weasel more than an opossum, for it is fast and aggressive. Without doubt, it is the most difficult opossum the writer has tried to handle, for it is strong, and wriggles and squirms until a finger or thumb is within reach, and then bites with telling effect. After making a few attempts bare-handed, a heavy glove covered with chain mail was used and although the teeth could not penetrate, the strength of the jaws was a constant source of surprise.

Bates (1888, p. 231) says that an opossum with soft brown fur not as large as a rat, was caught in a fowl-house. He may have

referred to a relative of this species. "The terrestrial species," he says, "are nocturnal in their habits, sleeping during the day in hollow trees, and coming forth at night to prey on birds in their roosting places." While the Brown Opossum is strong and fierce enough to prey upon birds of considerable size, the captive specimens were not as carnivorous as *Didelphis* or Allen's Opossum, preferring fruit to fresh meat or carrion, and thriving on it. No live animals were offered. It is significant that one was shot while feasting in a mango tree.

Litters of one and three were observed though there are five mammae. The pouch is much as in Metachirops. One female with a single young was received December 18, and placed in a cage where they were kept under observation until the following March. The young one, a male, was about two inches long and was able to stand alone, being more independent than a *Didelphis* of comparable size, but, like *Didelphis,* the control over the forelimbs was better than over the hind. He reacted with searching movements when touched, and when placed by his mother, he grasped her at once, seizing her over the hip, and making wide, sweeping motions with the head and anterior half of the body as though looking for a nipple. The mouth was fully formed, as were the eyelids; the hair was beginning to grow. In ten days he was fully haired with the same pattern as the adult, but both the brown and white portions of the pattern were duller. While he now spent much time out of the pouch, he clung to the female at all times, riding her back or hips. Although still nursing on January 8, he was seen away from the female for the first time. A month later and he was fully independent of her, so they were separated.

In addition to the cranial and color differences between the two genera, *Metachirops* and *Metachirus*, there are many others that are equally distinctive. Thus the eyes of the first show up as a reddish yellow under the hunting lamp while the eyes of the latter show red. The eyes of the young of both species show yellow. The difference in food habits has been referred to above as has that of disposition. *Metachirops* used the "tripod posture" more frequently than *Metachirus,* although the tail of the latter is a very effective appendage. One individual was shipped to the laboratory in the same box with *M. o. fuscogriseus* of approximately the same size. It had been thoroughly cowed by the more aggressive *Metachirus* and showed signs of having been bitten severely about the head and neck, while the aggressor was scathless.

Water Opossum

Chironectes panamensis

It is doubtful if this opossum occurs on Barro Colorado Island, for there are no streams that carry enough water the year around to meet its requirements. The following account of the animal is given by Zetek (1930, pp. 470–471):

"The only common name for this animal obtainable was 'Gato de agua,' a name used for nearly every mammal that frequents streams. Beebe calls it 'Yapock'"—a book name presumably derived from British Guiana. "The stream at Fort Sherman has running water and innumerable pools in its bed, of various depths. The bank was about four feet high. Shropshire's specimen was found about mid forenoon asleep on the ground above the bank and close to it. It had a very definite nest measuring about six inches in diameter made of leaves of various sorts.

As soon as the animal was disturbed it jumped into the water and dove, coming up shortly on the opposite bank and entering a hole about four inches in diameter, just above the level of the water in the stream. Upon exploration, it was found that the cavity was about two feet deep, somewhat enlarged at the end, and its direction downward at an angle of about forty-five degrees. It contained remnants of crustaceans and the part below the stream level was filled with water.

In the laboratory the opossum slept during the daytime, covering itself with whatever was placed in the cage. During the night it was very active. It ate shrimps freely, though dead ones only were placed in its cage. Attempts to photograph it during the first few days met with failure. It would never remain very quiet, trying to escape, and invariably kept opening and snapping its jaws. It would also hump up as if to jump, and when in this attitude the tail appeared to be very much longer than it really was.

After the fourth day it would allow itself to be handled and was much more quiet when photographed. Even so, it was not possible to use the camera shutter because the animal would move the instant the shutter clicked. Instead, a lense cap had to be used.

The specimen measured 20.5 inches from tip of nose to tip of tail; the tail was 12 inches long, of which the extreme two inches were almost pure white in color. The underparts, inner faces of the thighs, and the upper parts of the hind feet are white."

To the foregoing can be added the observations made on two specimens kept first in the laboratory, then in a large outside cage. The first specimen, a young male, was placed in a cage in the laboratory and given a quantity of grass. Into this he bored at once shaping a nest cavity by turning around and around. Whenever he was removed and fresh nesting material placed in the cage, he made a nest immediately. When transferred to the outdoor cage, a nest of dry leaves and trash was made at the base of a small clump of hat palms. Here he spent the day curled up tightly and was not easily disturbed. No tendency to burrow was observed in either specimen.

Since there were no shrimp available, the young specimen was given beef. He began to eat at 7:45 P.M. chewing the meat with considerable noise. Pieces were chewed off, using the back teeth as sectorials and then, even though the chunks thus cut off were large enough to cause straining, were swallowed whole. During this process the animal sat on its haunches using a somewhat tripodal posture and holding the meat in its forepaws with a skill much greater than that displayed by any other marsupial observed. Next day cooked crayfish was fed and again the animal sat on its haunches, manipulating the food with the forepaws. While he was eating, a seventy-five watt lamp was turned on within six feet of him without disturbing him. Carapace, antennae, and mouth parts were all eaten excepting the hardest portions. The jaws are powerful, the face appearing to be short because of the massive muscles of mastication.

Later, live crayfish were placed in the cage with the immature *Chironectes*. Although the body of one crayfish was as long as that of the opossum, he attacked and killed the crustacean. The attack was directed at the head which was reached by approaching from behind and parallel to the body of the crayfish. The strong jaws were used very effectively in crushing the anterior portion of the carapace.

Although *Chironectes* can climb, it is done unwillingly. Both specimens found little difficulty in running up the hardware cloth of which the cage was made. When placed on a branch, they used the tail either by placing it about the support or by holding it out stiffly thus using it as a balancing organ. This is quite in contrast to its use by other marsupials of the region. While prehensile and similar to that of *Metachirops*, it is too thick for effective use in climbing. On a hard rough surface there is a marked tendency to pull out the nails of the forefeet. Swimming was observed in a small pool of the outdoor cage. The use of the forefeet was not determined;

the hind feet were used alternately, the tail streaming out behind. Change of direction was apparently made by using the front feet and changing the body position. The broadly webbed feet are strong and effective propellers. The stroke is made along the median line so the hip region does not swing from side to side.

The eyes of *Chironectes* are very black and lustrous; the tail much stouter than in other *Didelphids*.

To the writer, one of the many amazing things about this unique mammal is the presence of a well-developed pouch in the male. The hunter who sent in the specimen to the laboratory insisted that it was a female and casual observation of the animal when it was disturbed and active led others to the same conclusion. But closer examination revealed that the scrotum was pulled into the pouch. Anatomical details of the structure of the pouch and the musculature involved in drawing in the scrotum will be reported elsewhere.

Mexican Long-nosed Bat

Rhynchiscus naso priscus

Numbers of this bat were found in the "sentry boxes" on Orchid Island. As the doors are off these small, abandoned, concrete canal markers, the interior is well lighted. Most bats occupying such places are very difficult to approach because of their alertness. Nevertheless, specimens were taken by hand from those boxes not too much infested with wasps!

Lesser White-lined Bat

Saccopteryx bilineata bilineata

These bats spend the day in places where there is much light. They do not appear to congregate in large numbers. A. B. Howell took four specimens that were hanging on the bare bark of a big tree. Specimens were collected from a shallow depression on a big tree and from the drying shed at the Las Cascades Plantation. As would be expected from this choice of roosting places, they are alert and restless if approached. At this last place, a lactating female with a half-grown young one was observed (May 21). This young one hung head down below the female, clinging to her while she grasped it with one wing. A slight tendency on the part of the females to roost in clusters, while the males were more solitary, was noted. A hollow

tree widely open at the top and filled by the rising waters of Madden Dam contained the largest group located. This group was composed of about sixty individuals.

Dog-like Bat

Peropteryx kappleri

This is another species which occupies places where there is considerable light. A colony was found in a series of small, well-lighted caves located in a hill near the mouth of the Rio Puente. They were very alert, showing their tongues between their wide lips in an amazing grimace, and then flying out into the sunshine and into other chambers when disturbed. Apparently they see well in full sunlight. They evidently had carried espavé beans into the cave, for the beans had been nibbled as is done by *A. watsoni*. A large unidentified snake occupied one chamber of the cave so only seven specimens were collected.

Bull Dog Bat — Fish-eating Bat

Noctilio leporinus leporinus

Many nights as soon as it was really dark, large, fawn-colored bats were observed flying over the water. They were most frequently seen in the Wheeler Estero where they came either to drink or catch small fish which abound near the surface of the water at this time of day. Dr. Chapman, who described the fish-eating habit of this group at Mono Island (1893, p. 206), was kind enough to spend several evenings in an attempt to collect a specimen. As they come out only after dark and fly very rapidly, we were unable to secure even one. Nevertheless, they could be seen well enough in the moonlight and under the hunting lamp to assign them to this genus, and possibly, to this species which is reported from Panama by Allen and Barbour (1923, p. 270) and has been reported since by Huey (1932, pp. 159–160).

Chapman (1933, p. 133) gives an excellent account of this genus, linking his first observations and doubts as to their use of the interfemoral membrane, and his discovery and observations of this fish-eater on Barro Colorado Island. "Here was proof that they actually ate fish, but thirty-eight years passed before I saw them fishing. Then, shortly after dark, on January 3, 1931, near the mouth of the Wheeler Estero, Barro Colorado Island, by the combined light of a

nearly full moon and a powerful, focusing flashlight, I saw a large, pale bat, about the size of a Nighthawk, which it resembled in flight, course to and fro low over the still water within a few yards of our boat. From time to time it dragged the surface of the water for a distance of several yards with its spread interfemoral membrane, producing a soft, swishing sound which I had heard before I knew its cause."

Nicaraguan Small-eared Bat

Micronycteris microtus

This bat was found associated with the Mexican Long-nosed Bat in the "sentry boxes" on Orchid Island. Others were secured from the under side of a fallen log as well as in a hollow tree on 23, Pearson Trail. This last group included a lactating female (May 8).

Panama Spear-nosed Bat

Phyllostomus hastatus panamensis

This large bat was taken in the caves at Chilibrillo and in old powder magazines near Summit. There is little to add to Goldman's report on the species (1920, pp. 185–186) except that, in captivity, they kill and eat smaller bats, and appear to thrive for some time on carcasses from the skinning table.

Dunn (1933, pp. 188–199) recently published a full account of the carnivorous habits of this bat based upon laboratory observations extending over a considerable period of time. Defibrinated blood, cockroaches, house mice, birds and other bats were eaten when offered. For a period of twenty-five days a specimen ate nothing but banana. When, following this period of fruit diet, a mouse was placed in the cage the bat killed it almost at once although this was done at 10 A.M. This bat ate three mice in one night which suggests the toll it may take of small mammals and birds.

Phyllostomus discolor

This species was taken in numbers from a hollow tree upon the Island. This tree would be occupied from time to time, but the bats would disappear irregularly for long periods, only to reappear later. In an earlier publication, (Enders, 1930, p. 290), the writer listed this bat as *P. verrucosus* remarking on the fact that the Panama specimens were consistently larger than topotypes from Oaxaca, Mexico. Speci-

mens taken from the same tree at a later date were identified by Miller, (1932, p. 149), as *P. discolor*, who said that "they differ slightly but rather consistently from the three topotypes of the Mexican *P. verrucosus* in their somewhat greater size, but in no other characters that I can discover."

Rusty Long-tongued Bat

Lonchophylla robusta

Several specimens were captured in a net as they flew over a pool in one of the caves on the Chilibrillo.

Short-tailed Bat

Carollia perspicillata azteca

This is a very abundant species hanging up in tunnels, under well protected bridges and in hollow trees. The body temperature in 99.2° with the air at 79°.

Pre-mature parturition was observed on March 15. Females taken that morning in a hand net, and placed in cages, gave birth that afternoon. When born the young were in the intact amnion which was removed by the female. To those observed but one young was born. No young survived more than a few hours from which the fact that they were premature was deduced.

Yellow-eared Bat

Uroderma bilobatum

While this bat has not been reported from the Island, it probably occurs there, as this species has been taken in palm trees at Gatun and Summit, and there are many such trees suitable for its use on the Island. Barbour (1932, pp. 307–312) gives an excellent account of the roosting habits of this bat and its utilization of various palms; he also points out the tendency of the males to roost alone while the females roost in clusters.

Jamaican Bat

Artibeus jamaicensis jamaicensis

This is another common bat that disturbs fruit bait whenever it can be reached. No roosting places were found. Several specimens

of this common bat were taken in Sherman traps and others in Schuyler and steel traps, using ripe banana as bait. Some of these traps were on the ground, others were in vines and trees. There is a very distinctive and repellent odor.

Watson's Bat

Artibeus watsoni

W. Lindsay took a specimen of this bat at Summit, and another was observed several times before it was collected in the Gardens. These bats spend the day clinging to the under side of the banana leaves. It is alert and difficult to approach, and, unlike Uroderma, is comparatively solitary. Mr. Lindsay assures me that this bat, too, eats espavé beans, and that espavé seedlings are found under their roosting places. As with the Dog-like Bat, it may be that not enough of the seed is eaten to interfere with growth. Unless it is for food, why do the bats collect the beans? And why do they carry them to their roosting places? The beans are too large to have passed through the digestive tract.

Goldman (1920, p. 204) took a specimen near the entrance to the tunnel of an old mine. That the usual habit is to spend the day under leaves is borne out by Chapman's (1933, pp. 555–556) observations on Barro Colorado Island. He found a solitary individual under the cut leaf of *Geonoma decurrens*. His interesting paper casts farther light upon the habit of cutting leaves so as to form shelters.

Mexican Vampire Bat

Desmodus rotundus murinus

These bats appear to occur over a large portion or all of the Canal Zone. Their attacks have been noticed wherever stock has been left unprotected at night. Apparently any mammal large enough to supply blood and more or less immovable while feeding is suitable. Calves in the pastures about Summit appeared to suffer most from the loss of blood occasioned by these attacks while the literature is replete with reports of horses and mules being much weakened.

In 1929, A. B. Howell took four specimens of this species in a cave on Taboga Island. They were roosting in hollow crevices in the caves into which he reached with a pair of long forceps. After the group was alarmed they were far too alert to be secured in this manner. Upon the

invitation of L. H. Dunn of the Gorgas Memorial Institute, a trip was made to Chilibrillo Caves to look for vampire bats to be used in his important researches at the Institute. A few were located in the smaller, more elevated galleries far from the other bats, but we were unsuccessful in capturing any individuals. Their alertness and evident resourcefulness was astonishing. On emerging from the cave we saw a boy who displayed three bites inflicted by a bat during the previous night, one above the left elbow, one between the fingers at the base of the left hand, and one between the toes. They were not bleeding nor did they appear to be severe. The natives in the region about the cave reported bites as being frequent but of no consequence. That attacks are frequent is not to be wondered at as the houses are nothing but palm-thatched roofs with pole sides, or open.

The attack of this bat can be avoided by hanging lanterns near the stock, a practice the worth of which is attested by the experience at the horse barn of the Cattle Industry. The attacks appear to be most frequently directed at certain regions of the body, chiefly below the fetlock and on the neck near the shoulder. This is, possibly, because the bat may hang upside down while feeding and the hair of the fetlock may offer a secure foothold.

A tendency to attack the same animal is marked. Darling (1911, p. 14) notes that sometimes only one horse in a stableful of animals may be attacked, while Lindsay told the writer how feeding bats tended to concentrate upon one of the three animals in the corral in Summit. Thus only one of the mules would suffer while the other two appeared to enjoy an immunity from attack. If the victim was confined and protected as was done if any sign of weakness was noted, one of the unprotected animals would be selected and utilized until it was, in turn, removed. What underlies this choice is not known. Of the feeding habits of the bat, Dunn (1932, p. 423) says:

"The vampire does not suck the blood, as popularly believed, but takes it up with its tongue, seldom placing its mouth on the wound except when the latter is first made or when the bleeding is very slow. If the wound bleed freely, the bat simply laps up the blood, hardly touching the tissues, while if the bleeding is scant the bat licks the wound."

Trypanosomiasis in time proves fatal to infected bats as Dunn shows, but they themselves are capable of transmitting trypanosomiasis to horses or other susceptible mammals. This disease may explain the apparent scarcity of the bat in the presence of an abundant food supply.

Disc Bat

Thyroptera albiventer

A single specimen of this rare and interesting bat was collected on the Island by E. R. Dunn (1931, p. 429). This individual was found in a curled leaf, three feet above the gound. Barbour (Allen and Barbour, 1923, pp. 271–272) captured this species "in the great, dry, curled-up Heliconia leaves."

Little Black Bat

Myotis nigricans nigricans

This bat was abundant about the laboratory where the day was spent hanging under the eaves. Two individuals lived inside the laboratory for several months. At times, this bat is very noisy, squeaking and fighting, hanging up on the wire screens with a great noise and then flying off again. These periods corresponded to the fullness of the moon. Another roost of this bat was located in a hollow tree on Orchid Island.

Coiba Island Mastiff Bat

Molossus coibensis

These bats shared the crevices under the eaves of the laboratory roof with *Myotis nigricans*. They appear to prefer dark places.

Crab-eating Raccoon—"Mapachin"

Procyon cancrivorus panamensis

Goldman (1920, p. 152) reports taking this raccoon along the Chagres and at Gatun. The writer found crabs dug out in a manner that appeared to be the work of this mammal, for the muddy tracks were those of a raccoon with blunt claws. Later Zetek said that this animal had been reported from the Island. Judging from the location of the diggings, the Crab-eating Raccoon frequents the small streams between Fairchild and Lathrop Trails.

Coati

Nasua narica panamensis

It is difficult to write anything new about the habits of the Coati for of all the mammals on the Island, this one has furnished the most

literary material. They are so abundant, so easy to see, and so interesting that this is only natural. For readers who wish a general account of the species, several accounts have been written, notably by Chapman, (1929, 1931) and Sharp (1930).

To the mammalogist, the Coati is most interesting because of the problem presented by its abundance on the Island. Protected from man, and with an abundant food supply they are far more numerous here than they are elsewhere in the Zone. Presence of numbers is felt all over the Island, but is acute about the laboratory clearing. How any bird or rodent survives is a constant source of wonder, for the Coati is tireless and cunning.

For some years, table scraps were placed in the clearing, and this food supply served to attract the Coati to the clearing. They became so abundant that those in charge decided that steps should be taken to reduce their numbers, so many were trapped alive, transported to the mainland and then released. This had little effect until the practice of furnishing a constant food supply was discontinued. Now, while by no means rare about the clearing, they are not seen so often, and what has been lost by way of their almost constant company has been more than made up by the restoration of more nearly balanced conditions about the clearing.

There are many about the clearing at all times, but their greatest concentration occurs at the end of the dry season. During this period, it frequently happened that eight out of ten traps would show the effect of their attentions. Three times in one day a band of Coati followed a trap line, knocking the traps about and eating the bait as soon as they had been reset. As with the other mammals they desert the clearing when food in the forest is abundant.

The strength of the Coati is astounding. Live traps must be very strongly made to resist tooth and claw. Neither will a small steel trap hold them; a Number two is the smallest serviceable size, but a size larger is recommended.

Not only is the Coati at home upon the ground, among the vines, or in the trees, but it is also a strong swimmer. One large male was trapped unhurt, a patch of fur dyed for purposes of identification, and than transported by canoe to a point some one hundred yards from shore. When dumped into the water he attempted to climb into the canoe and only vigorous use of a paddle kept him out of the cranky craft. After this discouragement he settled down to the task of swimming ashore. He proved to be a strong swimmer. The ludicrous, long nose was curled up well above the water, periscope-wise. On

landing, the Coati shook himself a few times, then walked into the forest; but within a week he was robbing the traps set about the clearing just as he had been doing before his experience.

The Coati is omnivorous. Insect larvae, insects, rodents, star-apples, pineapples, figs, espavé beans, bananas, papaya, palm nuts, almendro—all of which the writer has observed—are eaten, but this list is merely representative, and by no stretch of the imagination exhaustive for the Coati eats almost all foods. How many eggs and birds it destroys there is no way of determining.

There may be two broods per year, or no particular breeding season, for young about one quarter grown were seen in June and February. A pair, possibly breeding, were associated together in July.

Kinkajou

Potos flavus isthmicus

The Kinkajou is as arboreal as any Island member of the Procyonidae, and surpasses the Crab-eating Raccoon and Coati in this respect. No individuals were observed descending to the ground, all travel being through the trees, as was noted by Anthony (1916, p. 372) at Tacarcuna. They travel and feed only at night—a trait noticed in captive specimens of which pets have been made—but are much more active on moonlight nights than at other times. The days are spent in some dark retreat such as a dense mass of vines or a cavity in a tree, individuals having been dislodged from both types of resting place.

Although arboreal, the Kinkajous are not in a class with the White-faced Monkeys or the Squirrel, for while they move rapidly in trees and vines, progress from tree to tree is made with caution and no great speed. They dash along the larger limbs without using the prehensile tail as a "safety belt" by curling it loosely about the limb, but as soon as the slope is steep the tail is so employed regardless of whether they are going up or down. They run down small trees head first with the tail ready for instant use. Movement from tree to tree is accomplished not by leaping but by first advancing deliberately to the end of a branch then cautiously reaching for the nearest twig of the next tree. A female in moving thus, missed her objective, and as her hind feet were not on large enough twigs to give her a firm hold, her tail, which she had carried around the branch, was clamped down and served to bring her up with a jerk. This was the only time the writer observed *Potos* use the tail for prehension. On the second attempt

she grasped a twig, pulled the branch toward herself and secured a firm foothold before releasing the tail hold she had maintained. This performance in its essential parts was repeated at each passage.

The Kinkajous are most at home among the larger branches and vines. Here they move with speed and grace, leaping about in a very wonderful way on these aerial highways. As their eyes are large and reflect light when they watch the beams of the hunting lamp, their astounding gyrations are plainly seen as they rush about on the larger limbs or up and down the vines.

Anthony (1916, p. 372) reports a group of eight to a dozen individuals coming to feed in a fig tree. While Kinkajous do feed in bands, pairs are more frequently met with, and occasionally a single individual. For example, a pair was seen very frequently about the laboratory clearing—always two, never more. When separated by even a short distance, they called back and forth frequently, the call being a distinctive, plaintive whistle, "quit, quit," which changes in pitch, volume, and frequency when the animals are alarmed or excited. Another pair came to the clearing on the night of April 19. They were very noisy and to judge from observations extending over three hours, were breeding. On two occasions, April 22 and May 1, solitary individuals—both females—were observed. The first one was collected and proved to contain a very early embryo.

As far as the writer's observations go, the Kinkajou is frugivorous. Star-apple, almendro, mango, guava, avacado, and many species of fig are eaten. The insect larvae found in a few stomachs may have been ingested with the fruit, much of which is heavily infested. "Fruit seems to be their principal diet, but they doubtless feed on many other things. One partially filled stomach contained mainly fragments of large insects, but included small *Coleopterous* species swallowed whole." (Goldman, 1920, p. 160).

One was shot while feeding in a mango tree at Las Cascades Plantation. Feeding in the same tree with it was another Kinkajou and a Brown Opossum (*Metachirus*). When balsa is in bloom Kinkajou visit the trees nightly going from flower to flower, searching apparently for the insects within.

Bassariscus

Bassariscus sumichrasti notinus

One day, while shooting bats from a cavity which was located about twenty feet above the ground in an espavé tree growing at the water's

edge on Orchid Island, a Bassariscus was dislodged. It climbed slowly out of its resting place in the cavity and disappeared, although it was not seen to leave the tree. The size and color of the animal, and the large ears, together with the long, conspicuously ringed tail leads to this identification, which, if correct, adds considerably to the known range of this animal. As the writer was using nothing larger than a .410 handy-gun with small shot, no attempt was made to collect the specimen. Later another individual, believed to represent this species, was observed as it ran along a high limb. When it reached the end, it moved into the next tree, passing rapidly along the larger portions of the limb, but moving more cautiously when at the ends of the branches.

Otter

Lutra repanda

The Otter is fairly abundant on the Chagres River and various of its tributaries including the Chilibrillo. Glimpses of them are caught as they bask or eat on gravel bars or rocks, but they are very wary and cannot be approached. The men engaged in the Hydrographic Survey who travel up and down the rivers see them frequently but do not secure an opportunity to shoot them as they slip into the water before a cayuca can come within range. William Halloran reported seeing a pair about a snag on the Chilibre River under which, according to his rivermen, they had their den.

Goldman (1920, p. 165) reports that "near the mouth of the Chagres River they live along the banks and creeks up which the tide runs for some distance." Apparently they frequent running water for they are always found where there is considerable movement in the water. No signs were found about the Island, and Sylvestri, who was familiar with them on the upper Chagres, agrees that they do not occur on the Island. They are reported to be abundant on the Pedro Miguel River.

Tayra — Black Cat

Tayra barbara biologiae

All of the specimens seen on the Island were black headed, but the degree of blackness differed with individuals. A large male weighed fifteen pounds.

During the writer's stay, he saw but two Tayra, and both of those within a week. They are not shy animals and they move about freely

during the day, so thay cannot be very numerous. Nevertheless, five have been seen in one group here. They were growling and spitting at each other when surprised. This is not unusual; in another part of Panama, Carpenter shot two out of a tree where they had been fighting. It is possible that this habit of congregating has to do with the breeding habits.

Here is another animal that is always pointed out as a poultry and bird killer, yet a careful examination of the entire digestive tract of the two specimens taken on the Island revealed nothing but fruit pulp of a very agreeable odor. A few pupae of insects were also present, but these may have been in the fruit. Clark reports that the stomachs and intestines of two he examined contained food entirely of vegetable origin. That the Barro Colorado Island specimens were not forced to such a diet was evident from their excellent condition. Chapman (1929, p. 362) states ". . . . there can be no doubt that the Tayra should be ranked among the enemies of tropical birds, and with it we may head a list of their foes. Among mammals may be added the Grison, Opossums, Coatis, Skunks, Ocelots, Yagouarondi, Puma, and Monkeys."

Both specimens observed were traveling at a rapid rate along the forest floor and paid not the least bit of attention to the writer. Neither traveled in a straight line, but went from log to log in a zigzag course. On reaching a log, they bounded easily upon it, ran along it to the end, jumped down and ran to the next log. On the ground progression was made by a series of bounds. Their motions were beautiful and bespoke great muscular power. The source of this power became evident on skinning; the muscles of the neck were so heavy that the diameter of the neck was greater than that of the head, while the pectoral muscles stood out an inch above the surrounding structures.

About one specimen there was a pleasant, musky odor rather sweet when not too strong, but another male was as rank as any weasel. The first met instant death but the second screamed and bit itself before dying so may have released some of its glandular secretion. Aside from this musteloid odor of one, they were much "sweeter" than carnivors usually are. The feet were full of spines of the black palm, and the ubiquitous ticks were found between their toes. The duodenum contained several acanthrocephalids, *Oncicola sp.*, which, according to E. W. Price who identified them, may possibly represent a new species. The ectoparasites have not been determined as yet.

R. Hartzell reports that he found a nest of this animal in the tall

grass of the Cattle Industry pasture near Summit which contained three young. There was no excavation nor protection of any type to cover the nest aside from the heavy, overhanging grass. They are numerous here as well as at Alhajuela. One of the silver men living at Candeleria said that Tayra bothered his poultry, that a fox terrier would pursue such individuals which promptly took to a tree staying there while the dog barked at the base. When one realizes the strength of these animals, it is astonishing that they should "tree" for a dog.

Grison

Grison canaster

This species is recorded here since a few individuals have been found in the Zone, but they appear to be rare. Those who have kept them as pets report that young individuals are very well mannered and playful.

Panama Bush Dog

Icticyon panamensis

Questioning of hunters who had been up many of the rivers of the Chagres drainage system resulted in a distinct impression that the Bush Dog found by Goldman to range north to Mt. Pirre may be found nearer the Canal Zone. A companion reported hearing several short barks at Peluca, describing a series of sounds that I had heard the day before. These may have been made by a bush dog for there were no domestic dogs in the region or they may have been some other unrecognized animal.

Jaguar

Felis centralis

Although no one has seen the Tigre on the Island nor secured a flashlight photograph of it, it is included in the list of the mammals of the Island for the writer is convinced that it is a visitor.

It has been a growing conviction of the writer that among the larger tropical American cats the habits having to do with defecation differ to such an extent that the dung may be identified by size, location, and the treatment of the area after deposit. Thus the Ocelot may return to the same spot time and again until a consider-

able deposit accumulates; and there is no attempt to cover the material. The Puma, on the other hand, makes no such deposits, and makes a feeble attempt or none at all at covering; this much is a matter of observation. A third type of feces was found that surpassed in size all the others and these, located in the more remote areas of the Island, were well covered with forest litter. These may be the feces of the Jaguar.

"Few predatory animals are such wanderers as the Jaguar, which roams hundreds of miles from its original home, as shown by its occasional appearance within our (U. S.) borders" (Nelson, 1918, p. 413). This agrees with observations made in widely separate regions and there is no reason to believe that the same habit does not exist in the Canal Zone. Goldman (1920, p. 167) tells of reports of the Jaguar killing cattle on the savannas between Chepo and the city of Panama, also (p. 166) that it is well known to native hunters, favoring districts where deer and peccaries are abundant. Cattle have been killed in the pastures not far from Summit even more recently. Thus Barro Colorado is well within their range and there is an abundant food supply to attract the large cats.

Barro Colorado is an island, but water is not an impassible barrier to the tropical cats. While the writer was unable to verify a statement attributed to a Canal pilot, who claimed to have seen a large spotted cat swimming across the Canal, well substantiated reports from other tropical regions lend credence to this. Thus Holt (1932, p. 72) in his summary of the literature of instances of voluntary swimming on the part of the larger cats adds to Humboldt's report his own experience of Jaguars swimming. He quotes Seton (1925, vol. 1, p. 24): "It seems to be a rule that none of the tropical cats have any fear of water. It is well known that all of the felines love to be warm. They have not the fur to resist the wet, so in cold regions avoid the water. The Jaguar in its equatorial home is credited with many aquatic ways. It will swim rivers of any width when they lie across its path. It will dash into the water to attack an enemy, and is said by many observers to be an adept at catching fish." With such a habit, would it be surprising to find the signs of an occasional Jaguar when one considers the stillness of the water, its warmth, and the narrowness of some of the channels separating the Island from the mainland, coupled with an abundance of game and freedom from molestation?

Sylvestri, without any knowledge of the writer's notions on the subject, assured Dr. Barbour and me of the presence of the Jaguar

on the Island, saying that he had seen signs on some of the more remote portions of the trails. These locations were the same as those where similar signs had been seen by the writer a year or so before Sylvestri came to the Island. It was these signs that had convinced me. Moreover, Sylvestri went on to tell of the habits of the various big cats including the depositing and covering of their dung which corresponded with the observations set forth above.

On the other hand there is considerable negative evidence which has not been dismissed lightly. Old Mex, an experienced hunter, insists that no Jaguars reach the Island. As his experience on the Island was limited to a few weeks, it might be that during that period none visited the Island, or that he might have overlooked the signs. Chapman (1929, p. 217) refers to its cry, remarking that "it seems probable that if this animal were on the Island, sooner or later we should have heard its voice," adding, however, that the Jaguar "is first among the possible prizes awaiting the flashlight photographer on Barro Colorado." All the signs seen or reported are from the areas remote from the laboratory and, despite statements to the contrary, sound does not carry far in the dense forest, so the cries may not have been heard at the clearing. Moreover, Rhen (1934, p. 30) in writing of another sub-species of this cat says: ". . . . yet jaguars remain in considerable numbers, unseen and usually unheard" in the Pantanal of the Upper Paraguay.

Apparently, White-lipped Peccaries are more abundant in those portions of the Island where Jaguar signs have been seen than elsewhere; to judge from the signs, Tapir, too, are more numerous here than in less densely forested portions of the Island; Brocket Deer have been seen in no other place; while Agouti and Paca are also found here as are all the species of monkeys occurring on the Island; neither is it shunned by the Collared Peccary or the birds, et cetera, said to serve as food. (Seton, 1929, vol. 1, part 1, p. 23).

The dung considered to be that of the Jaguar is large in diameter, larger by a half-inch than that of the Puma. It was deposited at the side of the trail near logs and was well covered by leaves. The marks indicated an animal with a considerable reach, well developed claws, and a paw about five or five and a half inches wide. The claw marks were deep at the beginning of the sweep becoming shallow and disappearing before reaching the heap.

The dung could not be attributed positively to the Jaguar for it contained much of the same material found in that of the Puma. Peccary hair, species undetermined, and Agouti hair constituted

the bulk with a trace of Brocket, and, possibly, Three-toed Sloth of which there was very little. Some vegetable matter — roots — was included, probably by accident. Only three examples were seen and collected so the list is very incomplete. They were seen in July and August, 1929, on Miller Trail and in a ravine crossed by the Nemesia Trail. Similar dung, covered in the same manner and with plain tracks leading to the spot, was pointed out to me on the Pequeni River by another hunter. There was a clear area about the dung where the debris of the forest floor had been scraped over the pile. The hunter insisted, and the tracks supported his contention, that the dung was that of a tigre. He said that urine was sometimes covered in the same manner.

Old Mex insisted that Jaguar could be decoyed into range from a considerable distance but did not attempt it on the Island. This is done much as described by Nelson (1918, p. 413), taking into consideration the conditions imposed by a dense forest as against a canyon country. Moreover, instead of using a trumpet, Old Mex constructed a call by hollowing out a piece of balsa log six by twelve inches, and covering one end with dry deer-skin much as one would make a drum. Through the drum head he passed a thong which was knotted to keep it from slipping through the skin. In using, the call was held tightly, the right hand passed into the uncovered end of the call, and the thong caught lightly between the fingers as they slipped down its length. Some substance placed upon the thong made the fingers slip along it as though it were rosin-covered. At each stroke of the fingers the call gave a soft, far-reaching, mellow note, not unlike the calling of a domestic cow. This was repeated slowly at first and then more and more rapidly as the thong was slipped through the fingers repeatedly. This call is effective, whether or not it is an imitation of the female's call at oestrus as Old Mex says it is.

Ocelot

Felis mearnsi

"The Ocelot coat is the most wonderful tangle of stripes, bars, chains, spots, dots, and smudges. It has generally four stripes on the neck, two or three long links of black sausages down the back, and along the sides, chains of black-edged, brownish blotches which look as though they were put on as the animal ran by. All else is dabs, smears, and broken rings." (Seton, 1929, vol. 1, p. 141). And

withal, a mature male Ocelot from Panama is the handsomest cat of them all. A young male taken on the Rio Puente had the markings but the ground color was more pale than a mature male taken on Barro Colorado. The ground color of the latter was a richly golden orange that seemed to glow. The fur is well kept, glossy, but not deep.

The Ocelot of Panama is a large animal; the adult male referred to above weighed 34 pounds while the two year old male weighed 28. The only other spotted cats with which it might be confused are the Jaguar which is a much, much larger animal, and the rare long-tailed cat, the tail of which is much longer than that of the Ocelot.

Although the Ocelot may be strictly nocturnal where hunted, it is not so on Barro Colorado, nor in all parts of its range. "Several ocelots were seen during the day. . . . On several occasions while hunting in the forest I had glimpses of ocelots crossing small openings among trees, but none were encountered while using a hunting lamp at night." (Goldman, 1920, pp. 167–168). Osgood (1912, p. 60) reports seeing an Ocelot at midday. This is true of Barro Colorado; the only specimen trapped was taken between 11:00 A.M. and 4:00 P.M., and those observed were seen before 9:00 A.M. However, Dr. Chapman took flashlight photographs of two Ocelots at night — one at 2:00 A.M., which indicates that they may move about at all hours.

In another instance, an Ocelot deposited dung on the steps leading up to the laboratory some time between 2:00 A.M. and daylight, as the deposit had been made after the last rain which the gage recorded as having stopped at 2:00 A.M. The specimen secured on the Rio Puente was shot at 2:00 A.M. and another "shined." Thus it appears that they may be about at any hour of the day or night. This is borne out by their food habits, for some important food animals, such as the Agouti, are diurnal, while others, like the Spiny Rats and Paca, are nocturnal.

The Ocelot spends his life in the forest, but a few venture away from cover. Together with Jaguar and Tayra it is reported as having been seen in the pastures near Summit. Here there are bands of timber along the steeper slopes and, when the grass is high as it is from May until the following dry season when the land is burned over, there is excellent cover. Fire does not, however, destroy much of the forest cover in the ravines. On the ground the Ocelot can travel very rapidly. The individuals observed by the author were seen climbing down to the ground upon reaching which they ran away. Once the cat waited until the observer had passed before

coming down. This tendency was noted by Goldman (1920, p. 168), ". . . but when discovery became certain they ran down the trunks of the trees to the ground." The Ocelot is very inconspicuous unless in motion, so many must be passed without being observed. This habit of resting on stubs, high logs, and big limbs has won for them the reputation of lying in wait for prey which is, possibly, well deserved. It is also probable that the Ocelot does some hunting in the trees for they appear to be good climbers. Carpenter (1934, pp. 121–122) records one such individual attacking a young howling monkey. But the examination of the foods most frequently eaten leads one to believe that most of the hunting is done on the ground.

The natives with whom the disposition of the Ocelot was discussed, all stated that he was not dangerous, but was more so than the Puma, for he could not be trusted even free in the forest. They could not give any reason for belief nor recall of anyone being molested by this cat, however. They disagreed with Seton's statement picturing the Ocelot as "a big, simple-minded, good-natured cat." (1929, vol. 1, p. 146). Some pets seen by the writer were very friendly and good-tempered, while others were not. There appear to be more Ocelots kept as pets than Pumas, which may be because of their greater abundance as well as their smaller size.

The anatomy of the Ocelot is well worth a few comments. The forepaws are much larger than the hind paws, so much so that one common name is "Manigordo" meaning "fat-paws." Most illustrators show the Ocelot as a slender-necked cat; when the head is thrust forward as in hunting this is true, but it is not true in repose or when the head is held high. When the skin is removed the development of the neck muscles is such that the neck is larger in diameter than the head and may be as broad as the trunk. Thus, for its size, the Ocelot has a very powerful neck. The muscles of the forelimb and pectoral girdle display a considerable development indicative of a powerful climber.

Of all the mammals of Barro Colorado, the Ocelot offers the easiest subject for a study of food. This is the outcome of a habit that is, as far as the writer knows, unique among the cats — the habit of depositing dung in a suitable spot and returning again and again to add to this deposit. The resulting accumulation may be made by one or many individuals; nevertheless such a deposit furnishes a good idea of the food of the Ocelot. These deposits are not difficult to find, nor are they rare on Barro Colorado. They must exist wherever the Ocelot ranges even though they have not been reported.

By far the largest deposit was found in the hollow end of an almendro log resting ten feet above the ground within 100 meters of the laboratory. This accumulation yielded about a half peck of feces. Another spot so used was on Orchid Island in a concrete "sentry box" which, on being discarded, as a marker in the Canal, was placed there along with other unused materials. Other deposits were found on the steps under the doorway of the rear light at the end of Miller Trail; at the toilet of Fuertes House, at the toilet of Shannon House, located at the edge of the laboratory clearing, at the toilet at Redwood House, and under Bangs House. A single defecation took place under a shelter on the steps leading up to the laboratory; this was removed and no more were made while the writer was there.

The one thing all these accumulations had in common was their location under shelter and in such a place as to enable the animal to back up to some object such as the end of a hollow log, a post, or a door before defecating. The larger collections were in the better protected places and smelled of urine as well as fecal matter. When on concrete, urine was sometimes seen as well as noted by odor.

What can be the reason, the purpose of these deposits? Why are they so frequently associated with toilets? Are they the work of one or more individuals? The observations of the writer lead him to believe that Ocelots hunt in pairs under normal conditions, and stick to a given territory, and that these heaps serve the purpose of "sign posts" where he who runs may read. Since such a "sign" is made in sheltered spots it is preserved for some time even in this region of heavy rain. The odor of such deposits is to the human nose remarkably like that of the concrete-pit toilets used on the Island. Can it be that dung and urine are voided in response to this odor? How else can one account for the occurrence of dung at so many of the toilets when the nearby houses — used infrequently — offer all the conditions save the odor?

It is not possible at present to state whether or not these accumulations represent the dung of a single individual. If they mark the territory of an individual or pair they may be, but if they are "sign" of all Ocelots passing, they do not. The fact that there will be no feces deposited for some months when a deposit is removed only complicates the problem.

Another habit of the Ocelot is the clearing of space upon which to urinate. The urine is not covered after voiding, leaving the area bare. Whether this habit has any significance or a significance

similar to the depositing of dung was not determined. Because of the transient character of these deposits and relative inconspicuousness of these areas, no systematic study of the habit was made. Chapman (1932, p. 471) refers to these bare spaces on the forest floor saying that they are somewhat similar to the courts made by the Gould's manakin.

With these accumulations of feces so easy to secure, the food habits of the Ocelot can be learned without much difficulty. The food recorded here is based on examinations — some very carefully made in the laboratory, others in the field — of approximately fifteen piles, and the stomach and intestinal contents of two specimens.

First on the list of foods is the Spiny Rat, for all deposits contained the hair, spines, and bones of this octodont. Next in point of abundance of remains was Agouti. These two mammals constituted the bulk of the food in most cases. Snakes and lizards also constituted a considerable item, as did the Paca. Peccary hair, probably that of a young Collared Peccary, was found, as well as hair from the belly of the Brocket Deer. The Rio Puente specimen had made a meal of rabbit, *Sylvilagus gabbi gabbi*. Another specimen had eaten a Coati, while a third had suffered from a brush with a porcupine. Remains of *Oryzomys,* species unidentified, were recovered in several cases. While the Ocelot probably eats any reptile, bird, or mammal that it can overcome, no bird remains were found. A study of the food leads to the conclusion that the Ocelot hunts usually on the ground and does not catch birds often. On Barro Colorado Island, the Ocelot could live on a diet of Spiny Rat and Agouti alone. Their reputation as killers of birds and poultry is, the writer believes, unjustified.

One of the largest piles of dung was located on Orchid Island. This is too small an area to support a cat the size of an Ocelot, so the beast must, perforce, have swum back and forth between Orchid Island and Barro Colorado Island, or over to De Lessup's Island, and then across the Canal to the mainland. Orchid Island is separated from Barro Colorado Island by about one hundred yards of water; De Lessup's Island is about seventy yards away, while the Canal is one hundred sixty-eight yards wide at this point. Thus, to reach the mainland and an adequate food supply, the Ocelot must have navigated at least one hundred yards of open water at each crossing.

But the Ocelot is not always at home in the water. According to Donato and Sylvestri, during the heavy rains of November, 1931,

a cub was washed out of a den located on the stream to the east of the laboratory, and, in the course of its going downstream, was caught in some vines. Although the female called and stayed near the spot where the cub was entangled, she made no effort to dislodge the young one which was swept into the lake and finally drowned. Sylvestri as much as said that a man would have been a fool to have attempted a rescue with the mother about. The cub had only milk teeth.

Three nursing cubs were captured by a native near the Rio Gigante on February 28. Thus there may be two litters per season, or the young may be born at any season.

After the capture of the only Ocelot taken on the Island (Enders, 1930, p. 289–290), another came down the trail at dusk to within a few hundred feet of the laboratory, calling as it came. The call was much like that of the house cat, with due allowance made for the difference in size, and was more similar to the note ending in a rising inflection — like a distinct questioning, uttered when the animal is looking for other cats — than a yowling or fighting note. It was thought that this individual was a female, possibly the mate of the captured specimen.

The other specimen taken (on the Rio Puente) was definitely associated with a female larger and probably older than he. As he was fully adult — the testes were large and functional, although the cat was not fully mature — being at least two years old, it is hardly possible that they were mother and son.

These two cases combined with the calls and answers heard from time to time lead one to believe that Ocelots may hunt together or at least be companionable at certain times. The relations of the father to the cubs are not known.

All this is borne out by Azara who in writing about the Ocelot in Paraguay, says that they pair, and that "each pair lives in a separate district as may be inferred from a male and female . . . always being caught on the same spot." (1801, pp. 226–227). Lacy (quoted by Seton, 1929, vol. 1, p. 152) says "they often go in pairs."

How many Ocelots are on the Island? Few have been photographed, and only Carpenter and the writer report seeing any. But the tracks and dung deposits are abundant. Dr. Chapman photographed two on the same night no great distance apart — both appeared to be males. It may be safe to assume that they were not visitors to the Island although it was several seasons before another photograph of an Ocelot was secured.

Without assuming that Ocelots pair as Azara says, and as the writer believes they do, we have two as the minimum population of a rather restricted area. Add to these the Orchid Island Ocelot, and the one that used Fuertes House toilet and the rear light at Miller Trail, as well as the maker of the signs near the laboratory; and the Island has a population of five. This assigns no Ocelots to the vast eastern portion, nor the still vaster, densely forested western portions of the Island. The writer believes that no fewer than eight Ocelots live on the Island, and that twelve may be an understatement.

After an Ocelot is grown there is little to fear on the Island. The White-lipped Peccary could be avoided as well as, possibly, large cats. The many ticks found between the toes and in the pectoral and inguinal regions cannot be a great drain on the individual. Intestinal worms were found in both specimens dissected, but the animals were in excellent flesh. A few might suffer from attacking the porcupine, or from the spines of the black palm which were found in most of the mammals. The writer suspects that when the pressure of population becomes great, the surplus Ocelots swim to the mainland where they come in contact with their greatest enemy, man, from whose attack they are free on the Island.

Puma

Felis bangsi costaricensis

The Puma is seen more frequently on Barro Colorado Island than any of the other cats. This may be because of its habits or numbers. Elsewhere in the Zone the Puma is a rare animal because of its pursuit by hunters. Chapman (1929) records a Puma about the clearing watching a tame deer and has published flashlight photographs (1927, 1929) of Puma. He has seen Puma on at least one occasion. Others, too, have observed these big cats, and their tracks are seen frequently. The following communication from Carpenter is of considerable interest:

"I have frequently observed indirect evidence of pumas on Barro Colorado Island during my stay of over five months. These indications were fresh tracks, the squeal of a peccary, partially eaten animals which had been killed, and skulls from which the flesh had been torn a short time previously. Several times I had seen puma tracks coming from overhanging banks and from these I inferred that this kind of a place was frequented often by them. About one o'clock in an

afternoon of the spring of 1932, I was inspecting a dugout of some animal. The tunnel ran downward and inward toward an overhanging bank that was covered by masses of roots. As I raised myself from making an examination of leaves, tracks, and soil, I saw the head of a puma emerging from the bank some fifteen feet away. The animal then moved out in full view. From his size I would judge that he was an adult. He was beautiful. The dorsal portions were a deep reddish or chestnut brown somewhat similar to that of a forest deer. This deep brown became lighter and blended with whitish trimmings along the ventral surfaces of the belly, limbs, and head. His ears were erect and carried in a cat-like position, whereas his tail formed an upward-turning semi-circle. The animal moved slowly away, across a small stream and up a steep bank some twenty-five yards distant. Here he stopped and remained sideways, with his head turned, looking in the direction of the observer. For about one and one half or two minutes he remained still; during this time I focused my field glasses on him and these glasses seemed to bring him within reach of my hand. The beauty of his form and coloring, the grace of his movements, and the direction of his behavior away from the observer provoked no fear but great admiration and wonder."

As Carpenter indicates, the peccary is eaten, although the hair of the Collared Peccary alone has been found in the dung. The White-tailed Deer is eaten (Chapman, 1929, p. 207), as well as the Brocket. Chapman has observed a Puma eating a sloth which it may or may not have killed. Nor is smaller game scorned, for remains of Paca, Agouti, Spiny Rat, Iguana, and snake are also found in Puma dung. In food habits it differs from the smaller Ocelot, chiefly in the higher percentage of large game, and is certainly not the equal of the Ocelot in catching the smaller rodents.

Nothing is known about the home range of the Puma on the Island. It is suspected that individuals tend to frequent the same lying-up places but that they range all over the Island. It is not improbable that they swim from island to island or to the mainland. While they range all over the Island, tracks are most frequent in the more densely forested portions. As Carpenter says, Puma tracks are seen leading from overhanging banks, and Mexico saw a Puma leave such a resting place at Zetek 11. We returned several times but did not see him again. These resting places are often located where roots of a tree have stopped erosion at the head of a gully. Such a place is dry, is protected on many sides, affords a view of whatever passes up and down or across the gully, and offers a route for an unostenta-

tious retreat if the animal is alarmed. A large animal, possibly a Puma, was dislodged from a large hollow tree which offered similar protection at Pearson 22.

That the Puma is not strictly nocturnal is borne out by no less than six observations made on the Island, and the fact that Chapman secured an automatic photograph of a Puma at 11:00 A.M.

Dr. Chapman in a letter to the writer states: "You will remember that the first year I set camera traps I got five pictures of Puma, representing, in my belief, four individuals. I had only two traps, and the approximately eight or ten stations in which they were placed represented, of course, only a very limited area on the Island. Unless, therefore, Puma cover a wide territory in the nocturnal rambles, the four individuals photographed could have been only a part of the total Puma population which, at that time, may possibly have reached twelve individuals. This, of course, is pure guess work." We do not agree that it is "pure guess work," for this estimate is carefully arrived at by an experienced student of tropical life. Carpenter believes that eight or ten Puma are on the Island; Zetek believes the number to be higher; while the writer estimates the maximum number at sixteen. This last figure may be high, but it must be borne in mind that the food supply on the Island is large enough to support a larger population than this.

While the writer can judge only from indirect observation, he believes that the Puma is not increasing greatly. What factors limit the increase or lead to an almost stationary population are not known.

On several occasions calls have been heard that were, possibly, Puma. While the sound is easily distinguished from the call of the Ocelot, it is difficult to describe. Calls were heard only at night and chiefly in the region of the valley extending from Pearson, parallel to Miller and down to Nemesia Trails.

Yagouaroundi

Felis panamensis

Although the Yagouaroundi has been reported several times as a member of the Island fauna, it is to be suspected that the animal so represented was the more readily and frequently seen Tayra. It is included in the writer's list on the basis of observations of Ray Carpenter who saw, on four occasions, a cat-like animal running along

the branches and feeding upon figs in company with the Howler Monkeys. Each time the observation was made in late afternoon. Descriptions of the color, size, tail, type of foot, and method of feeding, as well as locomotion, establish the animal as a cat, and not a *Potos* or *Bassariscyon*. Moreover, Carpenter was familiar with the Kinkajou. Even though Carpenter is not, the writer is convinced that the animal was a red color phase of the Jagouaroundi. That it was eating fruit is no great surprise, as several of the Central American genera of carnivors do it.

Geoffroy's Squirrel Monkey, Titi

Oedipomidas geoffroyi

On Barro Colorado, the so-called Marmosets are seen frequently, but they may not be as numerous as the Howler. Elsewhere in the Zone they are by far the most abundant monkey for they occur in small second growth that is shunned by the larger monkeys, nor are they as easy to locate as the Howler, nor as eagerly sought for food as are the others.

The name of Squirrel Monkey is very fitting for, when they are seen far up in a large tree, or running along vines, or leaping, their color and tail, as well as size, give them a marked resemblance to the squirrel. In fact, the only specimen of this species collected on the Island was shot as a squirrel, the mistake not becoming evident until too late. These animals are lacking in the characteristics that make the other monkeys of such great interest. The voice is weak, their size small, and they lack the dashing activity of the White-face, and the gentleness of the Night Monkey.

On the Island, Squirrel Monkeys are seen almost everywhere, for second growth is as much frequented as the deeper forest. In fact, the deeper forest does not contain many for they appear to seek trees of smaller size, often near or about clearings. As Chapman notes (1929, p. 284), "They travel . . . usually at mid-forest altitudes and sometimes through the lower growth." Barbour (1923, p. 273) reports their coming into low bushes along the Sambu River. Similarly, they were frequently observed in the trees on the banks of the many esteros of the Island, as well as in the low growth along the stream from Las Cascades Plantation. Here numbers were seen in the growth that was impenetrable but not more than fifteen feet high. Numbers were observed in the rather small growth along

the Chagres, as well as that surrounding the natural savannas near this river.

This monkey is by no means as well adapted to the arboreal life as the White-face or Spider, and probably not as well adapted as the Howler. The toes, with the exception of the great toe, end in claws which, while useful in certain types of climbing, do not give the animal the purchase upon a limb so necessary for a truly arboreal type of primate life. Even in leaping, the feet and tail are disposed as much after the manner of squirrels as primates. In moving along a small limb the weight is carried on the foot which is placed at right angles to the limb, the claws pointing outward, the feet being advanced alternately. As a limb becomes more nearly perpendicular the angle is reduced until, in climbing, the claws take much of the weight. However, if the limb is large and not too much inclined, they gallop along, putting down the forefeet together, reaching forward with the hind feet together, and repeating. They do not give the impression of speed. No leaps were measured, but several were observed leaping from tree to tree across narrow esteros. Sylvestri says that they can swim well.

Most of the Squirrel Monkeys seen are in small bands, numbering up to a dozen and more (Chapman, 1929, p. 284). Sometimes single individuals are observed and very frequently, two. Whether or not such animals represent pairs was not determined. Many times attention is drawn to these groups by the chatter of the animals as they scold, and the noise made as they scurry from limb to limb apparently attempting to secure a better view. Even when not disturbed, the larger bands do considerable calling in a very high pitched, squeaky tone, possibly to maintain communication with the others of the party. Such bands are composed of animals of both sexes.

There appears to be a fairly well-defined breeding season in February, or even earlier. Many specimens taken from that month to June were pregnant. Birth takes place sometime in June to judge from the size of embryos at this time of the year. There are usually two young. Much work on the embryology of this species has been done by Wislocki.

Wislocki (1930, pp. 475–483) describes the glands found in this species. These are "complex scent glands, located in the pubic region, on the genitalia, or in the perineum" (p. 480). Both sexes have them, but "They are much more extensively developed in the female than in the male. . . . The finding of complex genital glands in marmosets is in keeping with the belief that the organization of the

animals is primitive and that they (Hapalidae) represent the lowest order of the Simiae." (p. 481.) A captive female was observed rubbing this gland along the perches in her cage. This behavior was frequent. What role this gland plays in the life of the animal can only be surmised until further observations of animals under natural conditions are made, as well as a study to determine its relation, if any, to the oestrus cycle and breeding behavior.

A wide range of food, both vegetable and animal, is eaten. The only stomach examined contained some unidentified seeds. Star-apples and figs are eaten as well as a variety of flowers. A band visited the balsa tree blooming near the laboratory with great frequency, as well as blooming cecropia trees. These visits may have been to drink the water that accumulates in the blossoms, to eat the flower, or to search for the insects found there. Some termites are secured by pulling apart dead leaf stems. Captive animals were very fond of insects, chiefly grasshoppers.

It is doubtful if this monkey is carnivorous, in spite of its insectivorous habit. They will eat cooked meat, but were never observed to more than sniff at it in the raw state. Mr. Zetek handed one captive specimen a bat (probably *Myotis nigricans*) which it took between its paws, turning it over and over to examine it, but making no attempt to molest it until the bat nipped a finger. With great rapidity the monkey bit the bat's head, crushing the skull, and then tossed the dead body away, taking no more interest in it. When sloths were confined in their cage, the marmosets would hunt insects in the long hair of the non-resistant sloths.

Panama Howling Monkey — Mono negro

Alouatta palliata inconsonans

Any contributions from the writer would be mere fragments when compared with the invaluable work of Dr. Ray Carpenter on this species. Because of his work the life history of the Howling Monkey is better known than that of any other mammal on the Island. The writer would add that man is a great, possibly the greatest enemy of this mammal. Thus a hunter reported that, having hunted for hours without success, he and his companions came upon a band of Howlers. They vindictively shot seventeen.

Lawrence (1933) has recently clarified the taxonomy of the Howlers of Panama.

Canal Zone Night Monkey — Mono del noche

Aotus zonalis

The natives on the Chagres insist that there are two species of Night Monkey differentiated on the basis of size, but those shown specimens cannot distinguish them on any other ground. The Night Monkey is strictly nocturnal, although one has been observed moving about after daylight, and is the only monkey on Barro Colorado Island that appears to have a definite sleeping place. This home is usually a hole high up in some tree or in a dense tangle of vines in the tree-tops. Nor do they move about in groups larger than family groups. These habits make them difficult to see unless one is familiar with their nesting sites.

As would be expected from a knowledge of their habit of living in holes in trees, they are limited in distribution to the more mature forest where such cavities are found. Here families were found living within a hundred meters of each other which may indicate a greater density of population than actually exists. Nevertheless, they cannot be called rare. When a suitable cavity is located and the animals take up their abode there, considerable disturbance is required to drive them away. For example, the animal, or animals, occupying a cavity in a branch stub near the laboratory were disturbed frequently when visitors pulled a rope attached to a nearby tree. This was done during the day to alarm the monkey whose face, when so disturbed, would appear at the opening to stare at the intruder; nor did the glare of a hunting lamp appear to disturb them to the extent of driving them away, either in their home or when feeding or at play.

The Night Monkeys about the laboratory appear to move about in pairs. This was also indicated by the fact that the hunters usually secured a pair at a time except when the young were with the parents. The data at the writer's disposal indicates that usually but one young is born at a time, and this one in June. Copulation was observed in December by Dr. Chapman. No pregnant specimens were secured after the twelfth of June. If December is the breeding season, this indicates a gestation period of approximately six months.

The young remain with the parents for some months, probably until the next breeding season. This tendency to live in pairs is noted by Allen and Barbour (1923, p. 273), and of the parents to be accompanied by young by Goldman (1920, p. 225). On June 12, a large non-gravid female was collected with a smaller male, evidently

immature. There were no indications that there had been a recent parturition, so it is possible that the male was born the previous year and because the female did not breed, remained associated with her.

July 2, 1929, a quarter grown Night Monkey was secured by hunters who shot the mother and captured the baby clinging to her. She was kept in the laboratory where she grew very rapidly on a diet of evaporated milk and bananas. During the day most of her time was spent in a hammock in her cage, for she was not active during daylight unless hungry or cold. When either of these sensations disturbed her, she would be restless and whistle and chatter until fed or covered. She was very sensitive to cold, for on dark, rainy days when the temperature dropped to between 74° and 78°, she would shiver and complain unless covered. When active at night, similar temperatures did not appear to affect her. Under forest conditions the Night Monkeys must encounter even lower temperatures, as temperatures of 69° have been reported over some of their range.

The greatest fear displayed by the captive specimen was when she was placed on the floor or the ground. As soon as the hand was removed she set up a great chattering, punctuated by a whistling "Khoo, khoo," and made for the nearest pair of legs. Up these she would climb, not resting until she was perched upon a shoulder. Photographing her was a problem for she would leap to the shoulder of the photographer whenever he approached within three and a half feet. Her vision was not adversely affected by sunlight, for she could follow every movement and could judge distance to a nicety; nor did she ever make any mistakes such as running into objects or taking hold of or climbing anything but human legs.

Altogether the Night Monkey is singularly peaceful and attractive.

White-faced Monkey — Panama White-throated Capuchin

Cebus capucinus imitator

This is the "mono cariblanco" of the native. While there are many on the Island, they are very rare in other parts of the Zone. This may be due to their being much hunted both for the sake of capturing immature animals for sale as pets, or for food.

This monkey moves about in bands which are surprisingly large and which trail along for distances over a quarter of a mile. Such groups are difficult to count for they are much scattered and may contain as many as thirty or more individuals. On several occasions

a solitary male was seen, but the usual group numbers about eighteen to twenty-four. The territory over which such a group ranges is very much larger than that of a clan of Howlers (Chapman, 1929, p. 288), comparing in this respect with the range of the Squirrel Monkey. Insofar as the Capuchin may occur in second growth forest, a large area of the Island is open to him. However, the small growth that may shelter the smaller Squirrel Monkey will not answer the requirements of the heavier animal. The White-face appears to spend the night in the higher trees which may limit its range considerably.

Chapman's (1929, p. 285) description of this animal in its native haunts is unequalled: "Here is a master of his environment. Not even a bird passes through the forest with greater freedom than this quadruped. He skips and dances along the limbs and, without pausing a second to measure the distance or select a take-off or a landing-place, recklessly hurls himself through space and, with arms and legs widespread, crosses openings at least ten to twelve feet wide."

There are at least two ways of making a landing following a leap, for when there is a definite objective such as a branch or trunk, they jump to it with only the forearms extended grasping the objective with these, and taking up the force of the leap with the hind legs which are more or less drawn up for this purpose. The tail plays no role in this type of progression. If, on the other hand, the landing is made in a mass of vines or a dense tree-top no particular portion of which offers a firm purchase, they leap or drop, as the case may be, onto the mass, flying through the air with arms, legs and tail widely spread. When walking along large limbs, there is a great curvature in the back with the hump just behind the shoulders, half the tail extending in a line with the body, the distal half curled up. On smaller limbs the tail may be carried so that the curl of the end is about the support.

The longest jump witnessed was an extraordinary leap from a tall tree to a tree-top fully fifty feet below and twelve or fifteen feet away from the take-off. A group was feeding in a tall tree in full view from the laboratory. One young individual had gone out on a limb near the top and was feeding quietly when a large animal, probably a male, advanced along the same limb and charged the smaller animal. Without hesitation the latter leaped, although the nearest tree-top was fifty feet below. The flight, for so it appeared, was made with arms and legs outspread, and the landing was safe, for the animal moved off as though nothing unusual had occurred.

The temper these monkeys display toward each other, is utterly unlike the behavior of the other genera. There is a great deal of commotion and scolding and fighting. The most terrific screaming was heard one entire day (Dec. 16) from a band of these monkeys; the commotion stopped during a rain-storm, but began again immediately after. That evening the group moved into some trees where they were easily observed. Although the screams had stopped it was evident that peace had not been restored. One individual in particular appeared to be attempting to join the band, but was kept away. This individual, apparently a young male, attempted to climb one of the trees in which the group was settling down. But at each attempt, one of the band would charge him, in the face of which hostility the solitary one always retreated. Although many different members of the group took part in this antagonistic display, the most active was a female with a large baby which she was carrying astride her hips.

Although frequently heard, this constitutes the only observation by the writer of the behavior of a group during or following one of these "disagreements." Chapman (1929, p. 287) says that the family life of the Capuchins is "excitable and aggressive. On occasions, unrestricted warfare seems to prevail, and with squeals and screams every member of the band is either in pursuit or retreat. They perform incredible feats of agility and fly through the tree-tops so rapidly that I have never discovered the cause of the disturbance. Apparently it is tribal rather than individual, for suddenly there is absolute silence, the fight is off, and the animals disappear." That there may be a cause has been suggested above. That it is tribal instead of individual and that some of this behavior may be the result of the group being approached by a strange animal is borne out by the behavior of a group that visited the clearing from time to time, often approaching the cage where Jocko, a captive Capuchin, was kept. Toward him they showed very definite rage, scolding and shaking limbs, some of which they broke. Jocko did not appear alarmed by these outbursts, but acted very much subdued, pressing against the netting of his cage and calling gently. Sylvestri assured us that the wild monkeys would have killed Jocko had we released him, and their savage attitude was enough to convince one of the plausibility of this statement.

When on the move, the group calls back and forth using a hoarse cry not unlike that of a human imitating a crow. This cry is given two, three or four times, usually, but the series may be longer — or

a single call given. Males call more frequently than females. Sylvestri would give a call quite unlike the Capuchin's cry, but Jocko always replied, even though Sylvestri was a quarter of a mile distant. This same cry has several pitches and uses. There is another type of cry used as a warning note, and sometimes before rain. When Jocko uttered this note even the marmosets stopped their chattering complaint for a few moments.

These monkeys show great curiosity toward man, peering at an intruder and hurrying from limb to limb in order to secure a better view. If one sits quietly, they will come very close, even to within fifteen feet if they are called. Where they have been hunted they are much more difficult to approach. The note used under such conditions is aptly described by Chapman as an emphatic "chung!", or a questioning "how?" These notes are uttered singly and not in series as is so frequently the case when using the "location" call.

This great interest and the warning call are not reserved for man alone. On two occasions — both times early in the morning — a group was observed that was absorbed in watching some object on or near the ground. The only sounds uttered were the alarm notes of the monkeys. As the writer had been attracted to the area by the calling of ocelots and as a large cat was detected on one occasion, it was surmised that some such animal was the object of the attention from the monkeys. A. H. Schultz observed a group of Cebus that were very much excited and alarmed. This was at 11:45 A.M. Four hours later it was found that an ocelot had entered a trap near the same spot and that within that time the cat had trampled down an area about twenty-five feet in diameter, had scratched up a sapling, and finally wedged itself and the drag between the roots of a tree where they were finally found. The writer is inclined to believe that the cat was caught soon after Schultz left and that the alarm displayed by the monkeys was over the cat.

When a large group of Capuchins pass through the forest there is a more or less constant breaking off of dead limbs. "One, hurrying through the tree-tops, stopped, went back a few yards over his route, and with some little effort broke off a decayed limb and threw it to the ground. Whether it had annoyed him or whether he considered it unsafe for future passage, I do not know." (Chapman 1929, pp. 285–286). Some of the limbs that fall are deliberately broken by the monkeys but once in a while one breaks under the weight of an animal, precipitating him into the lower branches. Such stubs are eliminated systematically from trees which animals occupy fre-

quently, such as the large trees near the dock. Not that one would attribute any real system of removal to the animals, but rather that the habit of climbing about the trees before settling down for the night and during the desultory climb, pulling at every stub as they come to it, results in the elimination of unsound footholds.

That some limbs are broken deliberately is beyond question. Limbs may part under the vigorous shaking of an angry animal, but whether the intention was that or not cannot be determined. The animal may be on the limb shaken or may grasp a nearby limb to shake it. That the breaking off of the limb may be the object is indicated by the observation, in at least one case, of a Capuchin grasping a dead branch in both hands, breaking it off, and then throwing it away in the direction of the observer. This may have been merely the restless expression of the animal's nervousness when being scrutinized, or the venting of an impotent rage upon an unresisting object. Nevertheless, the act was so deliberate that one is inclined to ascribe intent to this monkey. On the other hand, the animals sometimes break the limb upon which they are sitting, as was seen several times, chiefly in balsa or other trees with weak, soft wood.

The Capuchin is more carnivorous than the other monkeys of the region — a fact reported by Belt (1888, p. 118) and Chapman (1929, p. 289). Leaves and bark are searched for insects of all kinds. Leaf stems are torn apart and the termites extracted, using teeth and hands to expose the insects. Birds, nestlings, and eggs, are eagerly sought, according to observers. Sylvestri stated that "mono cariblanco" destroyed the eggs of a crested guan (*Penelope cristata*) that had built her nest in a tall tree near the clearing. To these items might be added arboreal rodents and, possibly, bats. Dr. Herbert Clark of the Gorgas Memorial Laboratory told of moving some packing cases in the animal house at the laboratory. A mouse ran out from under one and started across the floor of a large cage containing Capuchins. A monkey pounced upon the mouse at once, catching very cleverly, then calmly eating it. Dr. Adolph Schultz reports seeing captive Capuchins eating raw beef.

But the bulk of the food is vegetable in origin. Fruits of several kinds are eaten including the fig which is so abundant during the onset of the rainy season; star-apple and mangabe are eaten, too. Leaves of several species of trees are eaten and that wastefully, for just a bite or two is taken before the whole twig is dropped. Chapman (1929, p. 289) describes the persistent attempts of one individual to break open a large green nut. In captivity all the table scraps as

well as bananas, lettuce, raisins, grapes, and bread were eaten. This monkey is truly omnivorous.

Panama Squirrel

Sciurus variegatoides helveolus

This squirrel was observed in the second growth of comparatively small trees between Summit and Gamboa. From the young seen, one is led to believe that the breeding season is a few weeks earlier than that of the Canal Zone Squirrel. They live in nests which are compactly constructed of leaves and located in the tops of tall, slender trees. The nests here are usually placed on a limb at its juncture with the main stem against which the nest rests for additional support. There may be as many as one nest to every six acres in this region.

One young individual of this species that was seen was a very playful, friendly pet. He had been taken from a nest while very small and brought up in the house. He was not active after dusk.

Canal Zone Squirrel

Sciurus gerrardi morulus

The "Ardita" is the most frequently seen of the rodents for, while not as abundant as red squirrels in some northern woods, it is present in fair numbers. Instead of being most abundant in the deeper forest, it tends to occur where the mature forest lies near the second growth. In the region between Summit and Gamboa, where there is nothing but the smaller, second growth, this species does not occur, being replaced in this type of habitat by *S. variegatoides helveolus*, a species that is absent from Barro Colorado Island.

The voice and action of these squirrels is strongly reminiscent of similar behavior on the part of the northern red squirrel. At times they are quite noisy, while at others they are silent. One day they dash off through the forest before they can be approached, the next they may approach the observer. What underlies this difference in behavior could not be determined. There may be a strong territorial sense which may explain those cases where the squirrel came down to scold the invader. Nor were individuals on nut trees, or groups similarly feeding, disturbed by an observer. Solitary squirrels not feeding, on the other hand, usually made off at a rapid rate.

When the fruit of the nut palm (*Scheelea zonensis*) was ripe, the squirrels had an abundant food supply easily available. They peel off the skin, and eat the pulp surrounding the nut, and may eat the nut at times. Doubtless their diet includes almendro as well as many other nuts and pods. In addition to nuts, fruit is eaten of which figs are the most important. Star-apple is eaten, too, also other fruit.

Although no stored food was located, a tendency toward storage was noticed. Individuals carrying food, either to a favorite dining site or some storage place were observed. Two half-grown squirrels were seen carrying green leaves up a tall tree; for what purpose could not be determined. Food is so abundant most of the year that storage appears to be unnecessary. Moreover, at least in the rainy season, there would be a high rate of spoilage. The writer has no record of any attacks on birds' nests.

Apparently there is little or no relation between food supply and numbers. In the Forest Preserve and along the road to Madden Dam, abundant food is available, but no squirrels were seen except near Aqua Buena, probably because the animal has been hunted for food. On Barro Colorado, they are nowhere over abundant and are, in fact, absent from many portions of the Island. What limits their numbers is not known, but it may be their many enemies, for there are many arboreal snakes as well as carnivors in the tropical forest.

All the females taken in June were pregnant and active spermatogenesis was going on in the testes of all males, so it is possible that the breeding season corresponds to the end of the dry season or some weeks later. The usual number of embryos is two. In one case both embryos were in the left horn of the uterus. One female contained three embryos near term. There are three pairs of mammae.

In traveling from place to place this squirrel makes skillful use of all lianas as well as branches. Because of the intricate net of vines, movement from tree to tree is easy in most cases, but when a leap is necessary the animal does not hesitate. When undisturbed, they may come to the ground and explore around as recorded of the Darien sub-species by Allen and Barbour (1923, p. 265), or move to another tree that might have been reached by traveling through the tops. One individual was surprised while feeding on a small tree in a patch of young second growth. As it dashed off through the tangle with the brightly colored tail streaming behind, it was difficult to decide, on the spur of the moment, whether the fugitive was a squirrel or a squirrel cuckoo.

Canal Zone Pygmy Squirrel

Microsciurus alfari venustulus

All collectors agree that this small squirrel is difficult to secure either because of its rarity, or because it is difficult to see in forest cover. Although several were seen on the Island, only one which hung motionless for a moment was collected, for the others were too quick in making off. They may descend to the ground and escape by running over the forest floor against which they are difficult to see, or may dodge around a tree trunk and climb out of sight.

They show a decided preference for heavy forest and particularly the type of heavy forest where there is some undergrowth in the form of vines. In such places they are located with difficulty which leads to the idea that they are scarce. While not abundant, the numbers may be as great as the numbers of the larger squirrels. Both Carpenter and Mexico reported seeing them from time to time.

It is possible, too, that they are somewhat nocturnal, for on several occasions small mammals which were possibly this species were seen under the glare of the hunting lamp. That they were usually observed at the opening of a hole in a hollow tree or between buttresses of a tree suggests that they live in such places and that they were disturbed by the hunter in passing.

The only stomach examined contained material too finely divided to identify. That they occur in ivory-nut palm groves (Allen and Barbour, 1923, p. 365) might indicate that they eat these nuts. On the Island it is probable that they eat the nuts of *Scheelea zonensis* as well as other foods.

It is probable that the breeding season is in April, May and June, as in other squirrels, for the testes of one taken in June were active.

Canal Zone Spiny Pocket Mouse

Heteromys zonalis

A pair of pocket mice was taken, one entering a trap set under a log near a small stream, the other in a trap set on a log over another stream, both in deep forest. Goldman (1920, p. 116) reports that this species "inhabits rocky slopes of heavily forested hills near the Atlantic coast."

There was nothing characteristic of the foods eaten in captivity, but the feces were distinctive, being black, compact, and smooth

with a high shine. The specimens were taken in January. The testes of the male were very large; the female showed signs of recent lactation. There are three pairs of mammae, one pectoral and two inguinal.

Spiny Pocket Mice are not uncommon in the forest about the Chilibrillo for hunters there were familiar with it, pointing out the cheek pouches at once.

Peter's Spiny Pocket Mouse

Liomys adspersus

A single specimen of this lighter-colored, shorter-tailed pocket mouse was secured. It was killed with a machete while attempting to escape from a heavy stand of grass in the Experimental Gardens. The cheeks contained a few seeds of Guinea grass of which there was a great abundance at this time of year (June 20). The specimen was considerably smaller than a young female collected by Goldman at Empire. This species is confined to the dryer, more open and grassy portions of the Zone. If it were not for the yearly burning over of the pastures of the Cattle Industry which destroys their cover this would be an abundant mammal for it appears to thrive in tall grass.

Talamanca Rice Rat

Oryzomys talamancae

Experience on Barro Colorado coincides with Goldman's statement (1920, p. 99) that this is one of the more abundant species in the forest. A series of twenty could be secured in a short time if the collector were there during the proper season. Specimens were collected under logs and rocks in the forest, chiefly along Lutz Trail, but mostly in the wood pile and under the cook's house. From the records it appears that this rice rat concentrates here during the rainy season and scatters through the forest during the dry season. Food may be a factor, but rain with the consequent filling of their holes by water is probably more important. Banana was the most effective bait and specimens were captured in many types of traps — from steel traps set for larger animals to small live traps.

Captive specimens built nests of grass in the darkest corner of the cage and were not active until well after dark. The food eaten was

the same as listed for the Pygmy Rice Rat with the addition of a few insects in the capture of which this rat is adept.

They have two breeding seasons, or, what is more likely, they breed the year around to judge from the following records of embryos: July 1, 12, 20, and Jan. 21; with four, four, four and three embryos respectively. Individuals of all ages were taken in a period of two months. There are one or more moults per year. They suffer greatly from ectoparasites.

On one occasion a Coati was observed eating a trapped specimen, and on another a Coati was surprised eating one it must have caught by its own effort. Hair, possibly of this species of rice rat, was found in Ocelot dung.

Corazal Rice Rat

Oryzomys tectus frontalis

A single specimen was captured in a small natural clearing created when several trees fell some two or three years previous. The animal entered a trap set three feet above the ground on a dead stub. This, with the structure of the feet, leads one to conjecture a scansorial habit, a fact in keeping with Goldman's statement (1920, p. 101) that he took them where grass and shrubbery were mingled. The testes were active (February 7).

Pygmy Rice Rat

Oryzomys fulvescens costaricensis

This is the smallest rodent taken on the Island. From December 10, 1930, to January 1, 1931, when trapping was discontinued, five were taken under and about the Shannon House which is located in the clearing. The only trap that was effective was the Sherman. Some individuals were kept caged for two months, then released.

The stomach of one killed during capture, contained a purplish fruit pulp, possibly the fruit of a nearby star-apple tree. In captivity, their diet consisted of corn, Bermuda grass (*Cynodon dactylon*) and fruits, chiefly banana.

Several nests were seen, all of which were made of fine grass, located on the surface of the ground under the edge of some rain-shedding object such as the eaves of a house or a piece of tin and board projecting from a steep bank. No nests were found under

logs or stumps or in places where the protection was less than a foot above the nest. The nest itself is made of grass, is globular in shape with a diameter of about four inches, and with but one simple chamber. Captive specimens, when given Bermuda grass, made a loose nest at once, building it more compactly the second night, for they are nocturnal. When a pair were placed together, each built a nest. Two were never seen occupying a nest together, either in captivity or under natural conditions. One individual was placed in a wire cage, one end of which was darkened by slipping an opened box over it. In a corner of this darkened retreat was a nest of grass that had been built by a Cane Rat (*Zygodontomys*). The next morning a new nest, composed of the materials in the cage, was found under the edge of the box, all of the grass from the former nest having been moved to the front of the box where there was more light. What advantages there are in such a location, aside from dryness, are difficult to state.

Savanna conditions, to which the species is supposed to be restricted (Goldman, 1920, p. 102), may be imitated in the clearing under the houses which are set high above the ground. As most specimens were captured on rainy nights, one is led to believe that rain does not inhibit their activity, regardless of their aversion to rain in selecting nesting sites.

This mouse in appearance, locomotion and habits reminds one of *Zapus*. The long tail and large eyes, as well as the habit of moving in bounds which average a foot in length, increase the resemblance. One individual, on being given cotton for nesting material, did as *Zapus* does, frequently becoming entangled and losing some of the tail. Individuals so injured show the same erratic movements in jumping as does the northern mouse following the loss of the end of its tail. Under the hunting lamp they appear very alert and try to escape by dashing from one bunch of grass to another, being perfectly still between dashes, but making long jumps when closely pressed. A female captured July 15, contained three 10 mm. embryos. There are two pairs of mammae, both inguinal.

While this rat was fairly abundant in the short grass about the laboratory clearing during June and July, 1929, and from November to March, 1930–1931, none were taken in other clearings; and none were trapped nor any nests seen near the laboratory in 1932. It is possible that the heavy rains of November, 1931, might have destroyed the nests and young, or the rats may have migrated.

So small a creature must have many enemies. Peccary, coati,

or any of the carnivors would certainly destroy any young found in nests; nor are the adults so large as to be immune from attack by tarantulas which are common.

Canal Zone Cane Rat

Zygodontomys cherriei ventriosus

The Cane Rat lives in the clearings, avoiding the forest and even dense second growth during the rainy season. On the island numbers were taken at the Miller range light clearing and about the laboratory and in the banana clearing, while several were taken in the Gardens at Summit. However, they are, apparently, absent from the new Island plantation which may be too new to have been occupied.

The nests are of grass and were located at the ends of short holes which enter banks or pass under banana or palm tree roots. Paths may radiate from these holes. Specimens were taken on banana and corn chiefly by placing a live trap under fallen grass or under the kitchen where they came to feed on rice, bread and so forth left by an Agouti.

Pregnant or nursing females were taken November, January, March and April. One captive specimen had two young, others contained three, three, and four embryos.

In addition to rice and bread they eat Bermuda grass, corn, fruit of all kinds, and seeds. Once the dry season set in, no more could be captured in their old haunts, which may be explained partly by the abundance of food, partly by migration to the forest.

They are nocturnal. One male was released in the laboratory where he lived for more than a month in spite of the fact there were openings through which escape would have been easy. The day was spent in the dark room in a box of excelsior, but shortly after nightfall he would come out for food. In moving he dashed from shadow to shadow, never remaining in the light, and only eating when the food was in shadow. This differs from the behavior of *Sigmodon* which is diurnal as well as nocturnal.

Oecomys endersi

The specimen, kindly described by Goldman (1933, pp. 525–526), was taken in the top of a tree that had fallen into a small, natural clearing on Barro Colorado Island. It is probable that the species

is scansorial, if not arboreal. The feces are black, as in *Heteromys*, roughly round, instead of elongately cylindrical, measuring 3.5 x 5 mm. There are four pairs of mammae — two pectoral, two inguinal. There were three embryos (February 12); two in the right horn, the anterior one of which was moribund.

Boqueron Cotton Rat

Sigmodon hispidus chiriquensis

The Cotton Rat and the more abundant Cane Rat shared the clearings and both avoided the forest during the rainy season. The nesting habits are similar and they bear the same number of young.

The Cotton Rat is somewhat diurnal for specimens entered traps during the day. One was seen at 4:45 P.M., and allowed Donato to stroke its back with his hand!

This rodent suffers much from infestations of *Porocephalus sp.* which, according to E. W. Price who kindly determined them, are immature. They occur as adults in the lungs of snakes. The scrotum of one specimen gave the appearance of being full of these parasites.

Black Rat

Rattus rattus rattus

A few Black Rats were taken about the laboratory and kitchen, and one in the new plantation which is located at a great distance from the house. This agrees with Goldman's experience. Large numbers were taken in the Silver Quarters at Summit and Red Tank. In the greenhouses at the Gardens they did so much damage that poison had to be used to exterminate them. Specimens were secured also from the huts of Silver employees. It is probable that the following report of a native method of extermination applies to this rat, although it is possible that at times the infestation is by the Roof Rat (Krieger, 1926, p. 54):

"A peculiar practice is the Tule method of catching rats. As the houses are roofed with heavy thatch a large number of rats make it their dwelling place. On rat-catching day a representative group of men assembles at the house to be cleaned of rats and with clubs and long sticks climb on the roof and beat the thatch; as the rats descend the women and children assembled below kill them with clubs. The dead rats are then loaded in a boat and hauled out to sea and dumped overboard."

Roof Rat

Rattus rattus alexandrinus

A single specimen was taken on the launch belonging to the Island. As food supplies are brought over in boat the rat might have been introduced in this manner. She lived here for some days before being caught. At Summit, two were taken in mango trees the fruit of which may be damaged considerably by this rat.

House Mouse

Mus musculus musculus

Numbers of *Mus* were taken in the Silver Quarters at Summit, but House Mice were found nowhere else.

Porcupine
Puerco Pinna

Coendou rothschildi

The Porcupine is more abundant than one might suspect, for it is strictly nocturnal and largely arboreal. Nor is it very active even at night.

While felling trees for the laboratory clearing, several were dislodged from their hiding places. Carpenter located a specimen in a shallow burrow near Barbour Lathrop Trail, but was unable to dislodge it with a stick. Sylvestri brought in the skeleton of a recently killed individual which he found lying on the trail. The occurrence of the spines of the Porcupine in the skin of an Ocelot has been noted. This leads one to believe that, like its northern relative, it is attacked by the carnivors, possibly by mistake.

Of its food, Goldman (1920, p. 134) says, "One of these porcupines, purchased from a native hunter at Gatun, had its stomach distended with vegetable matter massed in two colors; a greenish part apparently leaves, and a white mass which had the appearance of fruit pulp. The hunter reported locating two in a tree by the light of a hunting lamp, but while he was securing one the other escaped."

Eight specimens were sent in by Mr. Shropshire's men and were kept in cages for about a month. The animals spent much of the day resting, sitting on their haunches and with the head turned in on the belly. At night they became quite restless endeavoring to escape. They feed freely on bananas both green and ripe.

Unlike the northern porcupines, the arboreal form is easy to handle. There is no switching of tail, which is not formidably armoured, nor any attempt to bite. The movements are not rapid although they can climb very well.

Spiny Rat

Proechimys semispinosus panamensis

This octodont, the macangúe of the natives, is the most abundant mammal in the moister, wooded portions of the Canal Zone. It inhabits the deep forests, living under logs, roots of trees, and in holes in the ground as well as in cut-over forest, brush lands, and in and about clearings and plantations. Its abundance may be judged from the fact that as many as five have been taken in one night by eight traps set about the clearing on the Island — an unusually high percentage for tropical trapping — as well as in the grassy areas near the edge of the lake and along streams.

Most of their activity is carried on at night. Of the numerous trips made after dark, on all but a few numbers of these individuals were encountered. Those in captivity would spend the day in some dark corner or under the litter, coming out to feed after dark. After a short time, however, they took to moving about during the daytime possibly because it was then that they were fed. They see well in bright light, but if undisturbed avoid it. None were seen before dark in the forest, but one sub-adult was observed near the laboratory attempting to enter a trap at 9:00 A.M. The trap was reset; at 5:00 P.M. the animal entered it. Another specimen was taken at dusk.

When exposed to direct sunlight for any length of time, the macangúe exhibits signs of distress and dies. If not removed from live traps before the sun is high only dead specimens are collected. Moreover, they consume much water, and appear to prefer damp, cool, hiding places during the day from which one might conclude that heat and dryness is a limiting factor in their distribution which is borne out by their absence from the drier portions of the Zone and Republic.

The food is as varied as the type of habitat occupied. Those taken about the lake had been eating Para grass (*Panicum barbinode*) and *P. grande*, while others taken in the plantation nearby had been feeding upon banana, sugar cane, corn and the fruit of *Physalis angulata*, another had eaten pineapple. In the forest almendro nuts are eaten, the covering without doubt and, possibly, the nut itself,

as well as the covering of the palm nut and fruits of all kinds. Stomachs examined contained star-apple, figs, and unidentified fruit pulp and plant debris. In captivity, a wide range of foods was readily taken including such foods as corn, rice, and bread. Nevertheless, grasses including Bermuda grass were always relished as additions to a fruit and grain diet.

The octodont is a singularly peaceful rodent. Individuals, newly caught, may be handled with safety if gently removed from the traps. Likewise, they may be picked up from the floor of the cage if not first driven into a corner. Usually they head into the corner and make no resistance, but may turn about and inflict a severe cut with the large incisor teeth, a fact soon learned by the man who cleaned the cages. Moreover, many may be kept together in a cage with no danger of fighting. They will crowd together in a nest, box, or corner and complain when others intrude; or scold when another attempts to rob them of their food but they do not fight. Even a young Marmosa was able to drive off a full-grown individual. Only one act of violence was observed and that toward a *Zygodontomys* which was occupying a corner into which a Spiny Rat chose to go. The smaller animal was seized with the teeth by the scruff of the neck and pulled out of the corner without any harm being done. The "scolding" sounds much like the noise made by guinea pigs. While the spines over the rump may be erected when the animal is frightened, this response is not frequent.

The Spiny Rat is not strictly terrestrial although most of the specimens were taken on the ground. Logs and overturned trees serve as highways to judge from numbers taken in such locations, some of which were ten feet above the ground. Where logs lie over small streams, they appear to form bridges over which Spiny Rats, Marmosa, *Heteromys*, and other small mammals pass. While about one hundred specimens were taken altogether of which approximately 20–25% had lost their tails, no specimens in this condition were trapped except on the ground. While the numbers are too small to be significant, they indicate that which will be explained later; namely, that the tailless individuals tend to avoid movements where the loss of balancing ability is noticeable as in running along small logs or climbing about them.

This leads to an interesting observation recorded by Allen and Chapman (1893, pp. 225–227) for *P. trinitatis* and quoted by Goldman (1920, p. 122) concerning the loss of the tail in this Panamanian species. The anatomical and histological basis of this loss in *P. s.*

panamensis is being studied and a report on the results as well as those of some experiments to determine how the tail may be lost will be made elsewhere. Here it may be said that such a loss is far from a handicap insofar as progression upon the ground is concerned. In fact, it may be of distinct advantage as far as speed is concerned for the tailless individuals are better adapted to terrestrial locomotion. The changes in locomotion as well as posture following the loss of the tail will be given with the other report. In this same connection may be mentioned the tendency toward syndactylism found in the hind feet of some specimens.

The reproductive cycle of the octodont differs from that of the rat, for while embryos were found from January to August, many adult females taken during that period were not pregnant nor did they become pregnant during several months of captivity under very natural conditions. Moreover, lactation is longer, lasting from March 13, to April 29 (forty-six days), in one case observed, and doubtless lasting longer. Two and three embryos are the usual number; no females containing more than three were examined. On March 11, a large female was isolated for observation. Two days later three young were born. While the writer did not see them at once, they were observed shortly after. They were fully furred, as was expected from the large, heavy embryos previously examined, and the eyelids were fully formed. They were very active, nimble and bright looking, and, while staying close to the female, were, nevertheless, rather independent. They made soft, whistling noises as they huddled about the female.

In eleven days they were tasting solid food, eating both bananas and dry corn during the consumption of which the action of the incisor teeth could be heard; but they continued to nurse. Two weeks after birth, grass and rice were added to the diet and while the young ate all the foods offered, they still nursed much of the time. At about this time the mother began scolding any young one that tried to take food away from her, nevertheless always giving up the food. The young were still nursing when observations were discontinued April 29. At that time they were not a quarter grown, had, in fact, grown very little since birth at which time the body was about two or two and a half inches in length.

After the young were about one month old, although still nursing, they did not always spend the day in the same corner of the nest as the mother. Specimens not very much larger wander into traps set under the houses about the laboratory clearing, indicating that

the family breaks up when the young are about two or two and a half months old. The growth from then on must be rapid as few half-grown young are taken.

Neither the pregnant female or any other captive specimen attempted to make a nest in the usual sense of the term, although given leaves, grass, and so forth. They usually hid under the litter without any systematic change in its arrangement. No attempts at digging or signs of digging were observed. Judging from this and from the condition of the young at birth, the writer is inclined to believe that no nest is made under natural conditions, but natural cavities and other protected places are used without modification. This belief was supported by observations of Spiny Rats living in hollow stumps, in holes dug by Armadilloes, and in rocky crevices.

The Panamanians insist that while they do not eat any form so low as this rat, the Colombians do. Goldman (1920, p. 122) states that they are eaten to some extent at Boca de Cupe, while a native of San Miguel Island assured me that the sub-species found there furnished an unfailing meat supply. This may well be for Barbour says: (Allen and Barbour, 1923, p. 264), "We tried them once when hard-pressed for food and then ate them regularly. The flesh is excellent."

Coati and *Didelphis* eat trapped specimens whenever they can get to them, so probably eat them in the wild whenever opportunity offers. The mobility of the young may be a distinct advantage in avoiding these enemies, although it is not, probably, a very effective method of foiling snakes. The first Spiny Rat identified on the Island was removed from the stomach of a *Boa imperator*. Doubtless everything large and quick enough to capture a rat is an enemy, but the worst enemy appears to be the Ocelot; this rodent forming, on Barro Colorado Island, the chief item in this cat's diet. A bot (*Cuterebra baeri*) was found in the left pectoral region of one individual. This bot is abundant on the Howler Monkey (Green and Shannon, 1926) but this constitutes a new host record.

By no means aquatic, the Spiny Rat swims well, striking out strongly with the front feet, using the hind feet irregularly, and tail not at all. Individuals living along the shore head in toward cover when disturbed, and cannot be induced to attempt escape by taking to the water. Moreover, if an individual falls in or is thrown in the shortest route to shore is taken. Nevertheless, they may cross small bodies of water voluntarily, particularly where grass-grown. This is borne out by the fact that it was found to be impossible to deplete

the supply of rats on a small islet which, under normal conditions, would not have supported more than three or four.

Agouti

Dasyprocta punctata isthmica

The Agouti is the most conspicuous rodent on Barro Colorado Island and may be classed as abundant. While its numbers do not compare with those of the Spiny Rat, they are nevertheless high.

While the smaller rodents are restricted to very definite habitats — *Zygodontomys*, *Sigmodon* and the Pygmy Rice Rat being confined to openings and brush land, and the arboreal rodents confined naturally to forests — the Agouti and Spiny Rat are found everywhere on the Island. That the Agouti is found in every type of habitat does not mean that its distribution on the Island is uniform; on the contrary, it is found in greater abundance in the heavily forested portions, particularly near ravines. In the very wildest portions of the Island, which happen to be fairly level, it is not so abundant. This may be because of the presence of enemies as well as the flatness of the ground and the height of the water table, which would discourage burrowing. Neither is this species particularly common in the smaller, second growth forest, where it is probable its numbers are limited by the available food supply. In other parts of the Canal Zone the Agouti is a rare animal because the tastiness of its flesh has led to a great reduction of its numbers through the activity of hunters and the clearing of the land.

The Agouti has been described as a small animal with a rabbit's head on a pig's body. When one is seen trotting along the forest floor, one is struck by the accuracy of this description. The Agouti is strictly terrestrial and is very well adapted to locomotion on the ground. There are several gaits used by the animal. When wandering aimlessly over the forest floor, the animal walks, using a gait similar to that of a horse, and is digitigrade. At other times, the animal breaks into a definite trot, but when surprised or attacked, the powerful hind legs are brought into play, and the gait becomes a gallop in which the hind legs and forelegs are used alternately — the forelegs held close together, and at each bound the hind legs passing around them to be planted in front. Most of the drive in this type of progression comes from the powerful muscles of the hind legs and back. While not being exactly the gait of the rabbit, for

there is not the disparity in the size of the fore and hind limbs, the use of the hind legs is strongly suggestive of the rabbit's as the hind feet approach the plantar position — all of which is most noticeable when the Agouti chooses to dash off uphill. Another typical pose in which the Agouti is seen is as it pauses, fore foot upraised, before it leaves cover, or stops to test the breeze. Then the forefoot is put down carefully and silently and the animal moves a few feet and then again "freezes," forepaw upraised.

Correlated, possibly, with the structure of the hind leg, is the posture assumed by an Agouti when alert or feeding. The body is held erect while the entire length of the tarsi rest on the ground, giving the animal a wide base of support, and leaving the forepaws free to grasp or manipulate food material. Usually, the haunches do not come in contact with the ground. The stability of this position becomes evident when the animal is observed closely, for it rocks back and forth with the claws alternately off and on the ground. The body is upright, the weight being centered near calcaneus. This is well illustrated by a photograph by Chapman (1931, p. 351). From this position the animal is able to start off in almost any direction and to attain great speed at once from the initial powerful thrust of the hindlegs. This may be of distinct advantage in escaping the charge of some enemies such as the carnivors. The quick getaway, the baffling change in direction, and the astounding ability displayed in dodging about obstacles depend upon the employment of the powerful hindlegs.

When, in their journeys, water is encountered, the Agouti does not hesitate to swim. Sylvestri observed one swimming voluntarily from Orchid Island to De Lessup's Island. He said that while the Agouti is about as good a swimmer as the Paca, it does not dive as does the larger species. The harsh and scanty vegetation of De Lessup's Island is not sufficient to support the Agouti population, so the home range of such animals as live there must be extended to include an area of more favorable growth, which can be done only by swimming.

The native name for the animal is "ñequi," which is, in all probability, derived from the sound the animal makes when surprised. Sometimes the Agouti remains still when approached, seeking, possibly to avoid detection by "freezing." When one approaches still closer, or when one actually surprises the animal, it leaps off shrieking "Ñequi! ñequi!" The movement is so abrupt, and the cry so startling that it never fails to surprise. Upon discovering it is not being pursued, it moves off quietly, grumbling to itself. When thus surprised,

the long hair over the rump is erected, but returns to its normal position as soon as the animal regains composure. It is almost inconceivable that such a loud and ferocious note could issue from the throat of so small and timid an animal. Whether this cry is for the purpose of warning or is merely the expression of fright cannot be stated. This startling cry is by no means the only note. There is also a shriek of pain and a soft, whimpering "conversational" tone used between the mother and young.

This Agouti lives in burrows, frequently along steep banks, a fact noted by Goldman (1920, p. 127). In addition to burrows located in such places, there are many under roots of which the Agouti takes advantage in the construction of its burrows. The writer watched the construction of several burrows of this type, the animal digging down under a large surface root, following the larger roots when encountered, but severing the smaller ones with its teeth. This makes a very intricate type of burrow, and one which it is all but impossible to dig out. Trees standing on higher ground are chosen probably to avoid the effects of heavy rains. One animal may be digging as many as three burrows at a time. At the far end of the burrow is a nest chamber the floor of which is scantily covered with dry leaves and sometimes twigs. This bedding is added to from time to time. The nest and burrow are free from excreta. Trails are formed by the Agouti leading from the burrow into the undergrowth or forest. "In places their paths up the steep faces of cliffs have been used so long that they are worn deeply into the surface of the rather soft limestone." (Goldman, 1920, p. 127). Such trails offer a safe and easy retreat. Frequently, when animals are disturbed while feeding in the forest, they rush over the edge of a nearby bank to disappear into their burrows. The speed which they make on such occasions is quite astounding. Also, they are extremely agile and sure-footed.

The home range of the Agouti is rather restricted. Under normal conditions, they remain within a radius of three hundred yards of their burrows, although in time of food scarcity, they may undertake long journeys to reach favorite food trees. It is also probable that even longer journeys are made in response to the mating urge.

The Agouti is a more or less unsocial rodent, each burrow being occupied, as far as the writer's observations go, by a single animal. In addition to being a solitary animal, the Agouti is quite pugnacious towards others of the same species. This antagonism appears to be as great between male and female as between individuals of the same

sex. The home range of an individual may therefore be dependent not only upon food supply but also upon the range of other Agoutis. From this it must not be understood that Agoutis are never seen together, for frequently they feed peaceably under almendro and fig trees. On the other hand, only once has the writer observed Agoutis together away from such feeding places without noticing the very definitely hostile attitude towards each other — even between members of the opposite sex, and on this occasion the two had come down to the lake to drink. Very few Agoutis are found that do not bear the characteristic scars made by the claws of others of their own species.

Where prosecuted, as in the Canal Zone, the Agouti is nocturnal. On the Island, Agoutis were seen at all hours. As a matter of fact, not a single one was seen during the course of night hunting, although they were abundant in the early morning and at dusk in the same territory. This condition differs from that found in its relative, the Paca, which is nocturnal everywhere. A female that lived about the clearing usually returned to her nest shortly after dusk unless she was hungry, in which event she would come at any hour if she were called. The day is probably spent resting in the burrow; the tame female would spend the day lying on the cool earth under the cook house. Also, while she was not afraid of light, she preferred the shadows, choosing to move rapidly from shadow to shadow even when the sky was overcast — a fact that made photography difficult. As long as there was light she would not linger under the open sky.

The food of the Agouti consists of many succulent plants growing on the forest floor. In search of this food they wander about sniffing and nibbling here and there. The plants eaten are chiefly herbaceous, representing many species. About the clearing some Bermuda grass was consumed. The herbaceous diet is supplemented by both fruit and nuts. Being terrestrial the Agouti must depend upon whatever drops to the ground, so only such abundant fruits as figs are available. Similarly, the outer husk of the palm nut is eaten, while both the fleshy covering and kernel of the almendro form an important element in their diet during the season of the year when these ripen.

A female without lower incisor teeth and but one upper incisor was very much dependent upon the laboratory for food. She lived about the place for well over a year, so ample opportunity was afforded to observe her choice of food. She ate bananas, papaya, ships biscuits, bread, lettuce, and partially boiled rice. Dry corn she would accept but did not eat except during lactation. This diet kept her in ex-

cellent condition. Once she was observed gnawing at some cooked gristle and, of course, she ate the placentae after delivery. (Enders, 1931, p. 395.)

When she had eaten her fill, food was carried off and buried in the ground. With a few quick strokes of the forepaws, a small hole is excavated, the food placed in it, and then pressed down with the paws, some soil placed over it and tramped down, then more soil added, leaving few tell-tale marks. The whole performance is remarkably dextrous for the Agouti is well equipped for digging. When replacing the soil it is pulled to the hole with the forepaws rotating outward and the strokes are deft and sure as those of a cat playing with a ball held between the forepaws. No discrimination as to the character of the food buried was shown; soft, easily spoiled food being buried along with less perishable food. So much food was offered that there was no necessity to return to stored food. If such a habit exists in the race, and nuts and fruits are carried off and buried in times of abundance, the Agouti may play an important role in perpetuating such trees as the almendro. Small pieces of food such as star-apple, almendro nuts and so forth, are picked up in the forepaws by which they are manipulated while the edible portions are cut off by the strong incisors.

Reference has been made before to the small home range and the pugnacity of the Agouti. Breeding behavior leads to considerable wandering about and to much fighting. Thus, a male was observed pursuing the laboratory female on November 16 at 2:00 P.M. She may have been pregnant at the time. The day after parturition, she went into the forest and was heard to squeal, emerging with a deep gash in the middle of her back. Whether or not it had been inflicted by a male Agouti was not determined, but, as most rodents breed soon after parturition, it is not unlikely that she had gone into the forest for this purpose. Moreover, Donato said that he saw her with a male Agouti, and that they fight thus during oestrus. Twenty-four days after parturition, she was seen to copulate. The fighting and noise that preceded intromission attracted the attention of all those about the laboratory. When observed a year later, this female was scratched up, for she had been fighting again. It would appear that many of the scars found on both sexes are the result of struggles attending mating. At no other time do they appear to consort together.

If the female referred to did copulate November 16, and it was a fertile copulation, the gestation period is 35 days, for parturition took

place December 30. This is not likely, for the gestation period in other similar rodents is approximately nine weeks, and, as the young are very well developed when born, there is little reason to expect a shorter period.

The usual number of young is two. The natives say that one is male, the other female; but observations made on pregnant uteri fail to bear out this contention. One uterus containing four embryos was seen. There are four pairs of mammae of which the two posterior pairs are better developed. Apparently there is no fixed breeding season, as pregnant and non-gravid females were secured during July and August and also in November and December, the only months when any were collected.

The young are well developed when born. Embryos of 135 mm. have well developed claws and a full coat of hair. In one case, when parturition was observed (Enders, 1931), the young attempted to nurse before both had had the umbilical cord severed; they also wandered a considerable distance from the mother, exploring about the nest area. The hair is well developed, showing the characteristic Agouti pattern and being longer over the rump. The eyelids are completely formed and the young walk and run about with ease. The male weighed 211 grams. They nibbled at the leaves which composed the nest within an hour after birth. When the mother "froze," they did the same, and when picked up and replaced, they maintained the position for a few moments.

About three hours after birth the mother and young left the nest, going to the forest, but returned in three hours. Two days later they occupied a burrow that had been dug a few days before parturition. This desertion of what had been the home of the mother for many weeks might have been the result of the presence of the writer, but why had a new burrow been prepared before this disturbance?

Had it been meant for the birthplace, but not finished in time, or does the Agouti usually move the young to another place? After the change she continued to enlarge the burrow for some days, then again moved — this time to the old nest site; then into still another newly excavated burrow on the hillside near the laboratory. This second move was preceded by very fierce fighting with another Agouti which the writer ascribed to breeding behavior but which may have been over territorial rights.

The female was much more difficult to watch after this, evidently avoiding going directly to the burrow; and she did not come out until dusk or dark. When she returned to her burrow, one young

one would come out to meet her. At this time, four days after birth, the young nibbled at various types of food and ate banana. They were very nimble. Shortly afterward the male disappeared and while the female young one stayed about for several months she never became as friendly as the mother.

The anal glands of the Agouti have a characteristic odor which is very noticeable when one is being skinned. This odor does not affect the flesh sufficiently to detract from its palatability. On several occasions Agouti were seen to evert the openings of these glands, rubbing the anal region against a root or tree. Also, when badly frightened these glands become active.

Man has reduced the Agouti population wherever he goes for the flesh is a valuable food. The Indian or negro may lie in wait near a hole for an opportunity to bag an animal but most hunters "shine" them. They are difficult or impossible to trap.

On Barro Colorado Island their greatest enemies are the cats and snakes, for the Agouti furnished much food for the cats as is demonstrated by the amount of their hair found in the dung. The relationship to snakes is difficult to understand. The tame female about the laboratory would react either to a Boa or the shed skin. On spying the snake she would approach it striking the ground with her hind legs as she advanced. The anal glands were protruded so that they touched the ground at each thump. The whole hind quarters were raised off the ground and the feet from os calcaneus to the claws, brought down with considerable force. This was or was not followed by scratching movements in which the hind feet were used alternately.

A *Boa imperator* was placed in one of the outdoor cages. When the Agouti became aware of its presence she approached it with the usual thumping and scratching. She came up to the cage and went on with the performance for several minutes before the boa struck at her. The intervening wire netting stopped the stroke in midair, but the Agouti whirled about, dashed away for a few feet, then turned about and repeated the performance. This type of behavior occurred day after day. After seven weeks the boa was released because it would not eat in captivity. Three days later the Agouti disappeared and was not seen again. One wonders at the significance, if any, of this in the light of the reaction of the Agouti to snakes.

Ectoparasites are abundant on the Agouti, both ticks and fleas being found. During the rainy season, patches of red ticks are found on the edges of the ears as well as the neck, and in the pectoral and inguinal regions, causing the animals to do considerable scratching.

Hunters insist that Agouti may be called with a whistle. The call is made in various ways, but all such contrivances give a sharp note that is made to "tremolo" by tonguing or by using a leaf. While the custom is wide-spread, calling was not attempted in my presence.

Paca

Cuniculus paca virgatus

Few pacas have been observed on the Island for they are strictly nocturnal, nor do they attract notice by uttering a loud cry when disturbed as does the Agouti. They were seen in the wild pineapple (*Ananas magdalenae*) on Armour Trail, on Wheeler Trail, and about the clearing, but chiefly along the shores of the lake where they were easily located from a cayuca by their noisy movements about the forest floor, and by the reflection of the light of the hunting lamp in their eyes.

The burrows in which they live are located in banks or on steep slopes, some of them communicating in the back with an opening at the top that is some distance from the edge of the quebrado. Carpenter called my attention to the fact that the openings of many Paca burrows were plugged with leaves. The purpose of this is not known, but it results in keeping out mosquitoes which otherwise swarm in such places. Such burrows were found along the bank of the stream west of the clearing, under the rocks in the old plantation and along many of the slopes all over the more densely forested portions of the Island. The fact that it is the rougher portions that are forest covered is thought to be more of a factor than the density of the forest for many burrows are dug in cleared slopes.

Paca is scarce in other parts of the Canal Zone, for hunters receive as much as forty cents a pound for undressed carcasses, so it is much hunted. In the Republic, the hunter uses small dogs and a hunting lamp which is a deadly combination, for when a Paca is started, its panic is so great that it seldom reaches its burrow. Those that are successful in reaching their burrows are driven out by small dogs. When not approached too closely, the Paca does not appear to fear the hunting lamp. When the forest floor is covered with dry leaves they move very noisily, so are easy to locate. But upon taking fright they run swiftly and quietly, quickly fading from sight. This is not so if disturbed during the day, for then they dash off blindly. One was driven out of a burrow in the new plantation; without hesitation

it rushed to the lake, dove, and disappeared. They enter the water voluntarily as is shown by their depredations in the new plantation, to reach which it is necessary to swim around the end of the animal-proof-fence which, crossing the neck of land, separates it from the rest of the Island. Sylvestri reported that Paca swim and dive with ease.

In the forest, roots are dug and fallen fruit eaten. In the plantation, they destroyed yams, cassava, and sugar cane, as well as other vegetables, and were the cause of bitter complaint on the part of Sylvestri. Among their favorite foods is the avocado. Enlarging upon this preference for the alligator pear, the natives say that the best way to hunt the Paca is to fill the pocket with small stones, take gun and electric torch, and climb into an avocado tree the fruits of which are ripe. After a suitable interval of time, a stone is dropped; the Paca hears the impact and taking it for the fall of a fruit hastens to the spot. All that the hunter needs to do is to flash his light upon the hungry animal and shoot it. Regardless of the truth of this recital, one has but to watch the avocado trees on the Island to be convinced that a fallen fruit does not remain undisturbed for long.

Forest Rabbit — "Mulita"

Sylvilagus gabbi gabbi

Donato insisted that there were no "Mulita" upon the Island; none have been recorded thus far. The only specimens examined alive were three captives; one taken on the savanna near Panama, another at Las Cascades Plantation, and another which was run down in the tall grass in the Experimental Gardens. Others were seen at the Plantation, where they were abundant, doing considerable damage to the young rubber seedlings. At dusk they came out of the shrubby, dense growth that has sprung up since the Plantation was abandoned to feed about the clearing. A lactating female was taken March 25, and two immature specimens two months later. The pelage and color are variable.

Collared Peccary —"Zajino or Zagino"

Pecari angulatus bangsi

". . . The Collared Peccary, or Zagino next to the Coati, is the most common of the larger mammals on Barro Colorado. It is frequently encountered in bands of from three or four to twenty, but the usual number is about eight to twelve." (Chapman, 1929,

pp. 209–210). Solitary individuals, both male and female, are seen from time to time.

Collared Peccary and peccary signs are abundant all over the Island, but they are more abundant in certain localities than in others, and the favored localities vary with the food supply and season. This peccary, as distinguished from the larger White-lipped Peccary, is more an animal of the undergrowth than the open forest floor. Not that it does not occur in open forest but it is more abundant where there is dense undergrowth, and it is through these thickets that the peccary make their trails. Thus, the greatest numbers of peccary are found where the forest canopy is not too dense. In the more remote portions of the Zone, peccary are fairly abundant, but they are rare or absent over most of the area. They are rare because they are hunted for food and because their destructiveness in gardens has resulted in their ruthless extermination.

The trails of the Collared Peccary lead not only through the bushy tangles of the shrubby vegetation, but everywhere. They are very conspicuous along the sides of ravines where they angle down the bank following an easy grade instead of going straight down and then up again. While the peccary is nimble enough, steep slopes are avoided for the clay is hard and becomes very slippery when wet.

The man-made trails are not used much by this species, although they cross them without hesitation (Chapman, 1929, p. 212). This is consistent with their habit of keeping to cover and to their own trails. Where the wild pineapple is too dense to penetrate, a man-made trail is sometimes used until a break offers an opening through which a peccary trail leads off again.

The trail of the peccary is narrow for they travel in single file when moving from one place to another. This habit results in well defined paths being worn particularly between feeding grounds and resting places and wallows. Such trails are easily recognized by the tracks as well as by their size. Final proof may be obtained by smelling twigs and branches where they have rubbed over the backs of passing peccary, for each contact with the musk gland leaves this characteristic odor.

When these trails pass through thickets they are too narrow and not high enough for a man to follow except by crawling along on the stomach, but this is well worthwhile for these trails reward the observer as well as the trapper for along them move many of the lesser mammals such as the Coati, octodonts, and several genera of marsupials.

Thus they constitute the highways through patches that otherwise would be difficult for small mammals to penetrate. This is particularly true of the trails through the dense growths of wild pineapple. These trails are not feeding trails but are the highways along which the peccary move. In feeding along the forest floor the band may spread out, rooting here and there as they go, and doing a very thorough piece of work to judge by the signs left in their path. They feed much as a band of hogs. But when moving from one place to another the band moves in more or less single file which, if the region is much visited, soon makes a trail. Even in open forest, this tendency to go single file is well marked.

"They are omnivorous, feeding on everything edible, from roots, fruits, nuts, and other vegetable products to reptiles and any other available animals. They are specially numerous in many tropical forests where wild figs, nut palms, and other fruit-bearing trees provide abundant food. In the arid northern part of their range, dense thickets of cactus and mesquite afford both food and shelter. Their presence in a locality is often indicated by the rooted-up soil where they have been feeding." (Nelson, 1918.) "In regions where they are little disturbed they have their regular feeding stations, called comederos, under fruit trees but where they are much hunted they quickly abandon this habit." (Allen and Barbour, 1923.)

Food varies with the season and the peccary shift with the changing supply. When almendro nuts are ripe, the cracked nuts are found under every tree and the trails of the peccary lead from resting place to tree, and from tree to tree. In eating the nuts the peccary "cracks the nut along the lateral seam that divides it into halves, a tribute to the hardness of his teeth and the power of his jaws. He also eats it unbroken, doubtless for what remains of its outer covering, since it passes through the alimentary canal entire. These animals, therefore, must play an effective part in the distribution of the almendro nuts and hence in the perpetuation of the species." (Chapman, 1931, pp. 349–350.) In addition to this nut the peccary eats whatever fruit, root, or bulb is available at this season. Star-apples are eaten as are succulent foods of various kinds to judge from an examination of the feces during this period.

With the passing of the almendro season, figs of many species furnish the chief item of diet until with the advancing rainy season their fruiting period closes. After the fig crop is consumed, the palm nut, *Scheelea zonensis*, furnishes the bulk of concentrated food. The outer covering of these nuts is eaten and by the time the next dry

season rolls around, few have escaped the attention of hungry animals. This food supply lasts for many months and although the fallen nuts may not be very choice food toward the end of the nut season, they furnish, nevertheless, an unfailing food supply which is deserted only with the ripening of the almendro. Probably the peccary assists in the dissemination of this palm much as it does with almendro.

Sylvestri showed Carpenter a tree called "Carano ediando" from which the bark had been gnawed and the gummy exudate that collected eaten, and assured him that it was the work of this peccary. Standley (1928, p. 224) says that there is a tree *Protium asperum*, called "carano," "from the trunk of which exude large amounts of a liquid resin of a peculiar strong agreeable odor," so the exudate may be natural although the flow may be increased by the attention from the peccary. Usually the Collared Peccary does not eat the seeds of the Monkey's Comb (*Apeiba aspera*), but when the almendro crop failed in 1932 they fed on *Apeiba* to a great extent. Standley (1928, p. 203) says of Cativo, *Prioria copaifera*, "Peccaries are said to be fond of the fallen pods." If so, the animals must be hard pressed for food, for no signs of any feeding by peccary were found at any time in spite of the abundance both of the tree and its large fruits. Chapman (1931, p. 350) also notes that this fruit is little, if at all, eaten by animals. Membrillo (*Gustavia superba*) is another fruit eaten in season. Peccary are "also attracted by the fresh growth of grass and sprouts in the clearing." (Chapman, 1929, p. 75.) "They feed on fresh growth of various plants and shrubs, often holding them down with their feet." (p. 210.)

Chapman (1929, p. 212) believes that this peccary is "chiefly, if not wholly, diurnal." They are most active during the early morning and in the late afternoon, a fact noted by Mearns (1907, p. 167) as well as by Chapman (1929, p. 210), spending the intervening hours lying under cover or in wallows of dust or mud. However, frequent observations indicate that feeding may be carried on at all hours of the day and night. Statements to the contrary notwithstanding, the peccary is easy to hunt at night for the eyes reflect light with a characteristic greenish tinge and are very conspicuous. When food is scarce or the animals are much hunted, most of the feeding may be done at night as hunters of experience verify. Nevertheless, where undisturbed, the animal is a lover of light. A captive specimen was willing to play at all hours of the day or night in marked contrast to deer and monkeys.

On moonlight nights peccary do much more moving about than

during the dark of the moon. In this they do not differ much from some other animals. When the moon was full a pet peccary spent much of the night pushing his feeding pan about the pen, but neglected this play when nights were dark.

How is the day spent? Field notes reveal that most of the bands observed up to 10:00 A.M. were feeding or moving to or from feeding grounds. From ten o'clock on, fewer bands are on the move while more are resting or wallowing until at 4:00 P.M. the bands begin again to move and feed. How late feeding is carried on has not been determined but two bands were seen feeding at midnight when the forest was very dark for it was in the dark of the moon. Resting bands have been observed from 7:30 P.M. on to midnight.

Of the opinions of how the peccary spends the night Roosevelt's statement (1893, p. 351) reflects the usual belief: "At night," he says, "they sometimes lay in the thickest cover, but always where possible, preferred to house in a cave or big hollow log; one invariably remaining as a sentinel close to the mouth, looking out. If this sentinel were shot, another would almost certainly take his place." Seton (1928, p. 731) states that he sleeps in some sort of den, and habitually takes refuge in a hole. Of this habit of hiding in caves, or logs, or holes the writer found no evidence on Barro Colorado, nor did the bands observed resting at night lie in the deepest thickets. If logs were so occupied the peccary odor would linger about them and feces would be found, for the peccary is much like the domestic hog in his dropping of dung anywhere regardless of the other uses to which the spot is put. Many hollow logs were thoroughly examined without a single one showing peccary sign. Although they root and wallow in the soft earth around the upturned roots of fallen trees, none were seen in such a location at night, nor were there signs of such occupancy. Such bands as were seen were lying under trees, chiefly palm trees, the leaves of which offered considerable shelter. The animals were lying about in groups of two and three, alert, and facing in all directions; no sentinel was seen. On taking alarm, the band would rise and move off slowly and silently.

All who have any acquaintance with the peccary speak of the musk gland which is located on the dorsal midline anterior to the pelvic girdle. The odor is not offensive and when not too concentrated is actually rather pleasant, in distinct contrast to the stench of the White-lipped Peccary, a fact recorded by Azara (1801).

Just what role this gland plays in the life of the peccary it is impossible to state. In both sexes it is well developed. The secretion

is brown to light brown, clear, and as fluid as light engine oil. It is not much affected by soap; alcohol dissolves much of it, and ether all of it. Musk is not secreted at all times, and secretion is increased by any excitement, pleasurable or otherwise. Nevertheless, there is always a distinct aura of musk about a band except, possibly, when they are resting and wallowing. Grant (1916, p. 387), says that "habitually, the boars rub their backs on low limbs to leave their trade mark behind, and thus mark out their range." The fact that the branches overhanging the trails bear evidence of this rubbing may or may not be so interpreted. Musking, under these circumstances, the writer is convinced, is accidental. On the other hand a young boar, kept at the Gorgas Memorial Laboratory, was observed, on his release from his quarters, to go up to a corner of a building, sniff the wall, then turn and rub his musk gland against the corner, a performance strongly reminiscent of a somewhat similar habit of the canine tribe. It is also true that certain trees in the forest are so much rubbed as to remove the rough bark, but this may be for the purpose of scratching, for ectoparasites are a source of considerable irritation.

Another pet peccary would play with the writer for a short time, then come up to have his head and jowls scratched, a proceeding from which he appeared to derive some satisfaction, then he would attempt to rub his musk gland against my knees, and on being held off would make a similar attempt to make contact with the hands that were holding him. If the fingers were run lightly around the area, he would stand comparatively still, the gland secreting actively the while. Thus the area about the gland may be an erotogenous area responding to touch.

When suddenly alarmed, there may be a secretion of musk, but, when the bands move off quietly, there is little or no, possibly less, odor than when feeding. The view expressed above that the gland is inactive while resting and wallowing is based on about fifteen observations, but is not to be taken too dogmatically.

The literature is full of references to the fact that the musk gland must be removed at once after killing the animal if the flesh is to be eaten. In two cases the writer killed sows and left the gland intact while the animals were carried over a mile, weighed, and skinned — an elapsed time in one case of two and a half hours. But the meat was not tainted; it was like dry and stringy pork, but there was no odor. How the flesh of sows in oestrus, or boars would be affected by the failure to remove the gland is another question. To the

delight of the Panamanian who helped in cutting up the carcasses there was a considerable amount of fat on the shoulders and in the omentum. The natives consider the animal very good eating, a fact that has much to do with the depletion of herds in settled districts.

A female containing two fetuses, 48 mm. in crown-rump length was shot July 16, (Wislocki, 1931) while a younger female killed December 1, was neither pregnant nor were her ovaries active. Young peccary the size of Agouti were seen in late January (Chapman, 1929, p. 192), and February 2; while a half-grown pet at the Laboratory in the period from July to the next February passed from a half-grown individual to one of about adult stature. It is possible that the young are born at any time of the year as Seton (1929, p. 730) states, but from observations on the Island, one is inclined to believe that most of the young are dropped early in the year for no young ones are reported at any other time. The young grow rapidly but judging from the development attained by one pet boar and the fact that no ovarian activity had taken place in a female probably a year old, they may not bear young until the second year. Azara (1801, p. 119) says the peccary breeds but once a year and has two young at most. This fits in with the observed facts on Barro Colorado.

A band, one member of which was the size of an Agouti, was approached as it was feeding. When they became aware of the approach, they retreated quietly to a nearby thicket leaving the young one alone and out in the open. The entire band lingered along the edge of the thicket showing neither marked hostility nor any inclination to bolt, so the desire to capture and examine the young one had to be suppressed. For a few moments the baby stood "frozen," then dashed into the thicket and moved off into the forest with the waiting band.

Just how a band or individual will behave under given conditions is difficult to predict. A large band may bolt with loud surprised grunts, or may fade away silently, or remain to stare for a time — even advancing toward the disturber before retreating. Solitary individuals vary as much in their behavior, but solitary boars are more inclined to bristle up, click their jaws and give a challenging grunt or two before bolting. Undoubtedly the degree of surprise as well as the availability of avenues of escape, and the proximity of the disturber, influence the reactions. If the band is down wind they usually move off quietly, moving so cautiously that only a few glimpses of retreating shapes make an identification possible, but if the breeze has not borne the odor toward the band, they may bolt

in such disorder as to divide. If they cannot be sure of being approached, they may stand very still and alert, staring at the point from which the suspected sound or odor comes with eyes unblinking, ears cocked, and nose busy trying to catch a telltale current of air; for the nose is most acute, hearing is less acute, while sight is rather poor. This sharpness of nose is well illustrated by the following passage from Chapman (1929, p. 210–211):

"At the end of January, 1927, for five successive days, six Collared Peccaries fed on the hillside in the clearing immediately below and east of the laboratory. They fed on fresh growth of various plants and shrubs, often holding them down with their feet. They were there from one to two hours in the morning and again late in the afternoon. If I approached them quietly from the leeward, they permitted me to advance to within forty feet and watch them indefinitely without showing any evidence that they were aware of my presence. If, using the same caution, I advanced toward them from the windward they retreated to the forest when I was still distant some sixty feet.

While sitting quietly on the upper steps of Redwood House I have seen a Peccary, feeding, come slowly from the forest into the clearing, where it soon sniffed the air. It gave no sign of seeing me; its suspicions were aroused not by what it saw but by what it smelled and it retraced its steps to the forest.

When approaching Peccaries from the leeward, their presence is sometimes betrayed by an unmistakable, characteristic musty odor. On one such occasion, I encountered a band of ten or twelve, including a mother with a young one about a foot in length. In evident response to a warning note, the little one remained motionless at a distance of about thirty feet while its mother, dorsal bristles erect, approached to within fifteen feet of me, first from the right then from the left, apparently trying to get my scent. Then it gave the alarm and with its offspring scampered off through the forest."

A band encountered on the trail was sent scurrying in all directions when an armful of metal traps was dropped with a clangor.

On several occasions bands were observed in their wallows. These were located in the forest, away from streams, where the soil was loose, either on gentle slopes or where the roots of an upturned tree had loosened the surrounding soil. Some wallows were muddy but most of them were dry. These wallows were used during the heat of the day, the animals lying about singly or in twos and threes.

The coat of the Collared Peccary is sleek and glossy in spite of its

sparseness and is kept in good condition. There are ectoparasites, chiefly ticks. The writer has observed neither fleas nor warbles. This clean appearance is very different from the straggly, mangy look of the larger genus.

The larger cats kill adult peccary without doubt. The small individuals might be eaten by the Boa, but the most important enemy is man who, in a region where both proteins and fats are scarce or expensive, hunts relentlessly.

The voice of this peccary has a pig-like quality. When feeding they may squeal and push much as do domestic pigs, but at other times they may be silent. When wallowing they give vent to little grunts that one is tempted to interpret as grunts of satisfaction! There is a "woof" of surprise, a barking challenge to a disturber, and a high squeal of precipitate flight. The surprised "woof" may be a single note sounded as the animal turns to face the direction from which danger threatens, or it may be uttered at every bound as the animals scatter. Also, there is a puppy-like bark which may be repeated time and again; this was heard only at dusk and may be connected with breeding behavior.

White-lipped Peccary

Tayassu pecari spiradens

This is the only mammal on the Island that can, by any stretch of the imagination, be considered dangerous, and then only under circumstances which are seldom met. They are for the most part nocturnal, occupying the more remote portions of the Island, and are infrequently seen — the first ones reported by a scientist having been seen by Dunn in 1929. Since then, others have been seen, but exclusive of the three that hung about the clearing for a period, only a few times. In spite of a definite search for the species, it was not until 1932 that they were encountered.

They were not very large. While no specimens have been weighed, comparison of size with the Collared Peccary of which several were weighed, leads to the belief that not many White-lipped Peccary weigh over one hundred pounds. They are slender and high, with massive heads. They do not appear to be sleek and well groomed like the smaller peccary, nor do they look as fat. The hair is sparse and very coarse, the skin showing dark between the hair. A group of visitors saw three one day, and laughed at a warning to treat them

with respect — they said they were too much like barnyard pigs to fear, and in the next breath begged reassurance as to their safety from any Pumas they might meet during a walk to the tower!

These three animals, a young boar, an old sow, and a mature sow, stayed about the clearing for more than a month in 1932. They were in poor condition, so it was thought that they came to the clearing because of the failure of the foods normally found in the forest at the end of the dry season. Here they fed on guinea (*Panicum maximum*) and Bermuda grass (*Cynodon dactylon*) as well as native species of *Paspalum*, and other low-growing herbaceous plants, fallen fruit, and whatever food, including bananas either green or ripe that was tossed to them. Undoubtedly, they played a part in the destruction of the root plants and bananas in the plantation. In the forest they were found feeding upon *Heliconia spp.* eating both the tender base of the stalk and the succulent leaf base as well as the thick, erect stems of *Dieffenbachia Oerstedii*. How they can eat this plant with its skunk-like odor and needle-sharp, irritating crystals is difficult to understand. Probably, whatever forms food for the Collared Peccary is eaten by the White-lipped too.

When the White-lipped Peccary moves into a region, other mammals move out. Thus tapir tracks were abundant on the stream beds and the delta at Fuertes House, until White-lipped Peccary appeared. No more tapir tracks were seen again until after the peccary left. A pet White-tailed Deer kept at the laboratory was very much alarmed whenever he winded them, but displayed no fear or agitation when Collared Peccary were about.

The trio about the clearing gave ample opportunity for observation of their habits. They were not nocturnal, though they did spend much of the day in a wallow which they made at the outlet of the drain from the laboratory shower bath. Enough water flowed out to keep the wallow muddy. This wallow was under a tree and well shaded. Another was by the side of the brook, which, although near the edge of the forest, was not used as frequently. When approached too closely, they left the wallow and disappeared into the edge of the forest where they stood watching the intruder. If, in using the lower path, one came between them and the forest there was a tendency to make a bolt for the forest on the part of the peccary, as well as a marked nervousness which was reflected by the cause of the disturbance. In one instance, when the writer was returning from a tour of his traps and discovered too late that the wallow had been occupied in his absence, he willingly let the wallowers have right-of-

way while he retired behind a tree with conveniently low limbs. Not that the peccary paid any attention to the intruder, they did not need to in order to bring about this action.

When disturbed, the jaws are clamped and the disturber eyed intently. Then, usually but not always, a retreat is made. The young boar did much more of the snapping than the sows, and was much more cocky. In fact, it was he who charged Shattuck while he was taking moving pictures of the group and approached too closely to them.

By tossing bits of bananas to them, the sows were coaxed to within seven feet of the camera. They showed little pugnacity, but clicked their jaws, after dashing off some thirty or forty feet. At other times, the old sow would walk off slowly, snapping as she went.

One afternoon, the same sow was standing across the path near the laboratory, so a stone was thrown at her. It struck her on the muzzle between the eye and nose. She wheeled about, turned her head toward the side from which she had been struck, and, snapping with great rapidity, swung her head upward and outward in such a manner that her formidable canine teeth would have inflicted a long, slashing cut had they encountered an antagonist. After fighting the air for a few seconds, she ran down the clearing and into the forest.

This peccary moves in groups of from three to a hundred or more (Chapman, 1929, p. 212). At times, solitary individuals may be encountered, but as a rule bands of ten to twenty are more common. Flashlight photographs by Chapman, and observation by Carpenter confirm this statement. If it became desirable, a large series of specimens could be collected on the Island for they are abundant in certain densely forested parts. Most of the encounters with this species, excepting the three about the clearing and the herd referred to by Chapman, as far as the writer knows have occurred beyond the tower and chiefly to the west of Armour Trail. Judging from signs they are most abundant in the large area lying between Fuertes House and Zetek. Donato refers to a herd of "several hundred" (Chapman, 1929, p. 212). This must constitute about the total population of the Island. It is difficult to picture anything smaller than a Jaguar being rash enough to attack a full-grown individual. They may not weigh over one hundred pounds, but they are nimble and fierce fighters. Moreover, since they are, usually, associated with others of their own species it would be more dangerous to attack them. Natives say that even the Tigre dare kill only stragglers and then is

sometimes forced to leap to safety. A solitary adult could be killed by a Puma and possibly by an Ocelot, but the writer knows of no such records.

One individual was found dead. Examination of the skull disclosed a broken tooth with the surrounding bone infiltrated with pus, so the animal died, probably, of starvation and the infection.

When moving or resting, individuals can be seen rubbing each other about the dorsal musk gland. This they do to a much greater extent than the Collared Peccary. The ventral surface of the muzzle is passed over the region of the gland, and the sides of the head rubbed along the flanks. The musk is characteristic, and a group that can be smelled but not seen is easily identified as White-lipped Peccary. He who said that their odor is "the quintessence of unwashed negro humanity" described the odor of the musk far, far better than could the writer. This odor is the most offensive encountered in the forest of Barro Colorado Island.

Chapman (1929, p. 212) refers to the use of the trails by the White-lipped Peccary. This species, unlike the Collared, shuns heavy undergrowth, neither does it make trails through tangles. Living in the dense forest, the floor of which is comparatively open, they move in a more or less compact group instead of single file as do animals passing along trails through tangles. This habit of moving in groups accounts for the numbers photographed by a single exposure.

The voice is not unlike that of the Collared Peccary. Apparently, the White-lipped is rare elsewhere in the Canal Zone, possibly because of the lack of primeval forest, and hunting. Along the upper Pequeni and Boqueron they appeared to be fairly common.

White-tailed Deer

Odocoileus rothschildi chiriquensis

The White-tailed Deer is more frequently seen on the Island than the Brocket as it finds considerable areas suitable to it. It "favors the forest borders of the dense thickets and mixed growth of small trees and shrubby vegetation which springs up wherever the original forest is cut." (Goldman, 1920, p. 77). As a sharp line of demarcation divides the Island into two nearly equal portions, the second growth lying to the east (Kenoyer, 1929, p. 214) — which portion is traversed by the main traveled trails — this is to be ex-

pected, even though this species of deer may not equal the number of Brocket Deer present on the Island.

Many White-tailed Deer are killed by the hunting clubs using dogs and hunting over the Pacific half of the Canal Zone where pasture and shrubby forest intermingle, reproducing conditions closely approaching those found in the forest above the savannas which is the natural habitat of this animal. Like the northern species this deer has extended its range because of its adaptability to clearings, agricultural and constructional, and the killing off of its enemies. On the Pequeni, where this deer was abundant, several "forms" were found. One such form from which we frightened the occupant at about 9:00 A.M. was in a spot that was fairly free from undergrowth. This showed signs of frequent use. Another was located on a hillside in a group of small trees which offered very little visual obstruction for the canopy was high, but did offer considerable impediment to a straight swift charge.

Native hunters, using the jack light, are killing these deer off at a rapid rate.

Pets of this species have been kept at the laboratory. One young male just old enough to develop horns would slip his collar, dash about the clearing for a time, then make for the lake from which he had to be forcibly removed. When pursued by dogs, wild individuals enter water without hesitation. This male would take food such as lettuce trimmings and pilot bread, and place them in the water of his pan before eating them, appearing to enjoy eating under water.

This captive was very much alarmed by White-lipped Peccaries, but not by Collared Peccary, the two species being, apparently, distinguished by odor and sound alone, as they were out of sight at the time. When a tame Agouti dashed into the clearing squealing in alarm, the deer stamped with one forefoot, then with the other. If irritated by a human he would rear up on his hind legs and strike rapidly with the forefeet, either singly or simultaneously. There was a tendency to rest during the afternoon, and then to feed actively during and after sunset, a habit of which Sylvestri took advantage by placing guinea grass in the pen for which the deer would dash when the rope was untied. In the morning flies bothered him a great deal causing him to do much leaping about.

The problem of whether or not this deer has a definite breeding season as does its northern relatives is of interest. The only way it can be solved is by a collection of dated early embryos in which project all hunters are coöperating. Goldman (in above) reports

a lactating female in January. Horns began to grow on the laboratory animal in April and by the first of July, he had attempted copulation with a mature female furnished by the Gatun Station Zone Police for a breeding experiment. Professional native hunters say that this deer has no breeding season, for embryos are found during many months of the year. Occasionally two fawns are produced.

On the island the enemies of the deer must be the larger cats. Chapman (1929, p. 207) reports excreta of either the Puma or Jaguar, probably the former, containing White-tailed Deer bones. They must be able to avoid the White-lipped Peccary which they appear to fear, but not the cats which hunt them for food.

Reports on the size of this deer vary. One buck, after evisceration, weighed 115 pounds, and another 140. These two bucks were larger than average, but indicate that while the Chiriqui White-tail does not attain the size of the northern Virginia deer, it is larger than the deer of Florida which are reported by Cory (1896, p. 63) to weigh about 80–90 pounds, but not over 110.

Because of the abundance of large cats on the Island, it is doubtful if there are more than eight or ten deer there. The food requirements of this deer are easily met as it appears to consume grasses and fruits, principally figs, as well as to browse.

Brocket Deer — "Venado Colorado"

Mazama sartorii reperticа

The Brocket is confined to the deeper portions of the forest which are remote from the laboratory and is very alert, so is not seen often; nor does it dash off when disturbed, displaying a white patch to advertise its presence, but moves off quietly if not too closely pressed. Brocket are fairly abundant, all things considered, in the region between Fuertes and Zetek, and about Zetek Trail. Carpenter and Dr. Chapman have seen Brocket, and old Mex reported seeing individuals here on several occasions. The remarks published (Enders, 1930, p. 285–286) apply to the White-tailed Deer (*Odocoileus chiriquensis*) and not to the Brocket.

Many skins and several specimens were seen on the Chagres where the Brocket is called "Venado Colorado." The flesh is eaten, the skins tanned, and the offal used in fishing.

With the clearing of the area to be submerged by the waters of Madden Dam, much of its habitat has been destroyed, which may

account for the numbers killed here. It is also possible that the opening up of this area to white hunters and the consequent killing off of the larger cats has resulted in an increase in numbers. The only record of a Brocket serving as food for a cat was secured on the Island where hair from the belly of one was found in the scats of an Ocelot.

Baird's Tapir

Tapirella bairdii

Alston (1879, p. 103) quotes a statement of Captain Dow that the favorite haunts of this tapir on the Isthmus "appear to be in the hills lying at the back of Lion Hill and the adjoining stations of the Panama Railway. It is only during the rainy season that they seek the lowlands." This region embraced Barro Colorado, so it is not surprising to find abundant signs of tapir on the Island.

As Goldman (1920, p. 82) remarks, "These tapirs are very shy and seldom venture outside of the denser forest cover." However, that they are not confined to such cover is demonstrated by the frequency with which they are encountered by dogs hunting deer in the quebradas in the pastures of the Cattle Industry. On the Island tracks may be seen at almost every estero, and baths or wallows on many of the small streams. Many appear to frequent the areas where, following the setting aside of the Island as a preserve, plantations were abandoned, leaving a very dense second growth which extends down to the lake shore with its heavy growth of grass.

It is not to be thought that the tapir are confined to water courses or the lake shore, for they appear to be great travelers and able to live at some distance from the water. This is borne out by automatic flashlight photographs made by Dr. Chapman, as well as by the deposits of dung found far from water. Moreover, the feces indicate that they browse in addition to eating the grasses (chiefly *Panicum barbinode* and *P. grande*) found in large masses in the lake. Here browsing is a more important item in their economy than grasses; whether the same holds true for the individuals living in and near the pasture lands was not determined as no feces or stomach contents were found. But in many regions such as in the mountains where tapir occur, grasses are not abundant.

In an old clearing on the Pequeni, tapir had been feeding extensively upon the wild papaya that had formed a considerable thicket. The trees had been straddled and then "walked down" until the stem

broke; the fruit was then eaten and here and there a mouthful of leaves from the top of the tree consumed. The passage of a tapir feeding in this manner makes a well-marked pathway of destroyed trees. In the same clearing Cecropia (*C. arachnoidea*) had been eaten.

Tapir may utilize one region for a considerable length of time as shown by trails they make, and the amount of dung deposited about wallows. Such trails are not very conspicuous, unless one happens upon them, for in spite of the great weight of the animals, the height is not such as to make a trail that is easily visible to man. These trails are particularly well marked where they lead across a narrow neck of land over which the animals must pass in going from one estero to another, or where they pass along the side of a steep declivity. They are also users of the man-made trails on the Island as Chapman's photographs show. Tracks indicate that the water courses are also used as highways.

There is a decided tendency on the part of the species to enter and emerge from the water at the same place, time and again. Nor is it improbable that more than one animal uses these entering places. Sometimes several trails may lead to one side of an estero, or inlet, but on entering the water all routes converge to one point, so that only one landing place is found. Similarly, animals traveling in the opposite direction all enter the water at this one place, but may leave it at any of a half-dozen places on the opposite shore. This suggests a deliberate choice of a point of departure where the tapir enters the water, and leads one to conclude that the native who insists that tapir do not swim but walk across an estero or river, regardless of the the depth of water, with the feet upon the bottom, has apparently observed the animals doing this, for all routes converge to a place where a sand bank, offering a much firmer footing than the soft mud of the rest of the bottom, runs out into deep water. It is easy to understand how an observer watching an animal walk out into the water along such a bar until only the back was visible and then seeing that disappear, only to see the animal reappear on the opposite bank, would gain this impression. For as Chapman's (1929, p. 229) photograph of an emerging tapir demonstrates, only a small portion of the head appears above the water — so small a portion that the animal must be all but invisible in poor light. Be that as it may, the native sticks to his belief that the tapir walks under the water, and frequently can point to a long sand bar along which the tracks of the tapir lead to deeper water.

Another belief, not altogether confined to the native, is that defe-

cation can take place only in water. To support this contention, the undeniable evidence of feces lying about wallows is cited. That defecation does take place in these baths is granted, but the tapirs living some distance from water could not return very frequently. Moreover, deposits are found on the hillsides, far from streams, where there can be no standing water. Carpenter reports seeing such deposits, too. Much time, apparently, is spent in wallows so dung is expected there.

These accumulations vary in size, doubtless with the length of use, as well as the frequency and the number of animals. Feces disappear rapidly in such a moist climate and with so many insects, so when a collection of dung balls covering an area thirty-five feet in diameter was found, it was interpreted as the product of more than one individual.

The feces are rounded, somewhat smaller than a baseball, and reflect the nature of the diet. Most of the balls are rather dry, consisting largely of woody fiber that has passed through the digestive system of the animal with little change. Others indicate a less resistant fiber — as of grass — in which case the feces are more moist and are not unlike, in content as well as moisture, the dung of a horse that has been feeding upon succulent grasses.

The baths or wallows may be located in a small stream in a basin at the bottom of a waterfall, in an estero, usually where a small stream enters, or in a depression. If in the latter, it is abandoned as it dries up with the waning of the rainy season. Such a wallow may be very extensive, one found in a depression on the neck of the point where Bang's House is located being thirty-five or forty feet in diameter. Insofar as they wallow in both wet and dry seasons, it is possible that wallowing is resorted to in order to avoid the mosquitoes, flies and other insects, or in an attempt to allay the irritation of the ticks of which they have many.

Usually, tapirs are nocturnal, spending the day resting in thickets or vines or near logs. No tapirs were surprised in daytime in their wallows, and, as these baths were often muddy in the morning, it may be that they are resorted to chiefly at night. Sylvestri reports that while clearing a trail, he jumped over a log onto a pile of brush under which a tapir was sleeping. The surprised sleeper dashed out and made off, but did not go far before stopping to stamp and snort.

Paddling along the shore of the Island near the watchman's shanty which is but infrequently used, Sylvestri drew my attention to the

snort of a tapir we had disturbed. We located the bed in the tall grass near the lake shore from which the occupant had fled, but neither saw nor heard any more of that tapir.

Mexico agrees with Carpenter and Sylvestri that, when surprised, the tapir may snort and stamp with its forefeet. Some natives fear the beast for this reason. At other times, particularly when started by dogs, they rush through the brush and tangles, making much noise. One man on horseback came upon a tapir in the pastures and shot the animal while it stood gazing at them.

To judge from this last incident, sight is not very good, which raises the question of the keenness of the various senses in the tapir. From reports of observers and from photographs examined, one is led to the belief that hearing is most highly developed. The structure of the outer ear encourages such a statement, also. The snorting and circling of an animal when surprised may be an attempt to catch the tell-tale scent of the disturber. At least when really frightened the eyes do not function any too well, for while the fugitive does not bump into large trees, small stuff is passed over or through in what has every appearance of a blind dash. Of course the weight of the animal carries it through tangles that to the eye of man appear to be impregnable, so this lack of visual discrimination may be far more apparent than real.

What the enemies of the tapir are aside from ectoparasites cannot be stated without reservation. Of course, some on the mainland are shot by hunters, but on the Island, only their natural enemies limit their numbers. While young, any of the large cats could easily kill them, and doubtless the Jaguar could kill adults. Tracks on the Island indicate that the young stay close to the mother until about half-grown.

In 1932 tracks of a very small tapir associated with an adult were seen on the Wheeler Estero, and those of a half-grown specimen with adult tracks accompanying it near Peña Blanca, indicating that reproduction is going on on the Island. The period of gestation is commonly reported as 400 days, so reproduction is not rapid.

But how many "mountain cows" are there on Barro Colorado Island? Chapman, in a letter to the writer, draws attention to the fact that his photographs indicate that tapir cross the Island, a habit that increases the difficulty of estimating their numbers. He places the number at ten or twelve. Sylvestri said that there were ten males and as many females; Donato said there were not as many as twenty; Carpenter believes the numbers are even smaller. Twenty is the

number the writer would assign to the Island, believing that number to be conservative.

Apparently tapir do not share the same feeding grounds with the White-lipped Peccary. Thus tapir tracks were abundant along the stream near Fuertes House in late 1931, but no more were seen leading to what had appeared to be a favorite wallowing place, once the region was occupied by a band of "Puerco del monte." In February of 1932, the Puerco moved out of the territory which, within a month, was reoccupied by tapir. This same observation has been made in several places but what underlies it was not determined. It is doubtful if competition for food is the determining factor for feeding habits are not similar. More likely it is a problem involving the use of wallows, or just plain antagonism toward the tapir on the part of the peccary, or fear on the part of the tapir. Since the foregoing was written, Carpenter has sent the writer the following:

"Tapirs are rarely observed even by careful naturalists working in regions where they are numerous. On Barro Colorado Island where they abound I saw only one instance of their behavior. Furthermore, during twenty-six days of field observation work on the La Vaca River of Western Panama, I made only two contacts with living animals.

I was attempting to locate a clan of Howling Monkeys on Barro Colorado Island in January, 1932. The region was between Shannon and Barbour Trails. Suddenly two bulky forms sprang up before me, the larger snorted, advanced in my direction, and at the same time stamped the ground, presumably with her front feet. The animal which came toward me revealed clearly its downward turned nose typical of the tapir. I would estimate its height at approximately thirty inches, and from the brief glimpse that I was afforded of the lesser one, I would guess that it was about half that height. For fifteen or twenty seconds the large animal continued its stamping, snorting, and apparently aggressive activity; the young one moved away from the observer. When I approached, in order to get a better view, both animals dashed away through the tangled underbrush while the larger of them continued to make the snorting noises.

In the vicinity of the La Vaca River tapirs are unusually numerous as judged by tracks and other indirect evidence. The tracks of several different animals may be seen in the space of three miles along the river. About one o'clock one morning as my guide and I were hunting for these animals with hunting lights, we heard one come

down a steep bank, and then saw its eyes flash as points of reddish light from the reflections of our lamps. The animal turned and ran away in the direction from which it had come. Its presence was confirmed the next morning by the fresh tracks.

The La Vaca River is a very winding water course especially towards its source in the hills. Tapir do not generally follow the course of the channel but cut across the higher ground or hills around which the river flows. Often they climb very steep banks and knolls over which their toes afford them secure traction. Trenches three or four feet in depth are to be seen where tapirs have formed pathways; the trenches were probably cut by generation after generation of tapirs and by the action of the water. Native guides tend to follow and depend on the tapir pathways and frequently cut in half the time that is required to reach a certain point on the river by following the tapir trail rather than proceeding in the river channel.

Once my guide and I came upon a place where there were several tapir beds around which were piles of fecal matter. Evidently the tapir had used this place as a bedding spot many times and the various trails leading out from this vicinity support this conjecture. The location was on a high hill and in a place of fairly dense vegetation. Some three hundred yards from this spot we heard a large animal come slowly toward us then stop, turn, and dash off in the opposite direction up a bank. Later we observed the soft ground considerably scarred by the tracks of a tapir. The indications are that tapirs are very keen of sense in detecting strange living things.

Tapirs eat coarse, tough ferns, palm leaves, and grass that would not be eaten by either horses or cows. Also there are several species of trees from which they gnaw the bark of the buttress roots."

Three-toed Sloth

Bradypus griseus

While sloths occur on the Island they are not seen frequently for they spend much of the day immobile and when they do move, it is so slowly as to attract no attention. Moreover, they appear to frequent taller trees. There is no reason to believe that there are fewer sloths on the Island than in the forests on the mainland where, to judge from the numbers purchased from natives, they cannot be considered rare. The Three-toed Sloth is more abundant, or possibly the easier of the two to secure, for in response to an offer

of a dollar for each female Three-toed Sloth and the same sum for any Two-toed Sloth, more than twice as many of the first genus were secured.

The Three-toed Sloth is notoriously difficult to keep in captivity. However, if given an abundant supply of cecropia leaves and sufficient room, they thrive. In addition to cecropia leaves, they also ate the leaf of an unidentified herb which grew in the clearing, but did not do well on this food. Many sloths were thus kept, some for a period of months, and much of what is here recorded was learned by observing the captives.

Ample opportunity was given to check Wislocki's observations (1925, pp. 320–321) on the posture of this genus of sloth. When not traveling along a limb the body is more or less perpendicular; even when feeding this posture may be maintained. As Wislocki says, it "spends most of its time asleep and waking in a sitting or squatting position, its hind limbs embracing a stem or crotch of a tree, while its arms are free to be used for grasping foliage to be guided toward the mouth or for climbing . . . when asleep, the hind extremities are used for support."

The offspring, of which there is but one, is well developed at birth. It clings to the mother much as a young monkey, for the mammae are pectoral. The young one, although usually seen with the limbs about the thorax of the mother, may shift to the back — always maintaining a more or less upright position. One was observed hanging onto the hair over the rump of the mother which was in turn clinging to the wire netting of the enclosure with the weight supported by the hind legs. This caused the thorax to rest upon the anterior aspect of the hind legs, so eliminated the space usually occupied by the young one. This is, probably, a frequent occurrence under natural conditions.

In captivity, the animals do little or no fighting, even when there are several males and females in the same cage. However, when two females, one of which was carrying a baby were placed together, the one without the baby attacked the other during their first night together. The baby was clinging to the pectoral region of the mother when the attack was launched. She curled up to protect the baby, covering effectively, while the attacker chewed her left hind leg. The mother shrieked more or less constantly during the fray, but settled down as soon as they were separated. The leg was lacerated to a surprising extent, in view of the thick, tough skin with which the sloth is covered.

It is possible that there is a somewhat definite breeding season in this genus. Females received in January either had babies with them or were pregnant or both. However, one which was received on December 9 carried a good-sized baby, which died December 29. The mother was observed copulating, and when killed January 29, proved to be in the early stages of pregnancy, the embryo being in the late somite stage with limb buds according to Wislocki. Females taken later in the season were not pregnant.

Copulation extended over a period of two days. A young male was placed in the cage on December 30. It was observed from time to time that the two animals were together. Assuming the position venter to venter, the male which was the smaller of the two, embraced the female with both fore and hind limbs. This embrace would last for several hours, the little moving about that was done during this time was accomplished through the efforts of the female for she carried the male much as she would have a very large baby. In fact, it was not until later when the uterus was examined and she was found to be in the early stages of pregnancy, that copulation was suspected. As this was the only male in the cage and the animals were under constant observation, the writer does not suggest that it was at this time that impregnation took place. Two days after the onset of this activity which, as has been said, covered a period of two days, the male was killed by accident. The placentation of this sloth and the characteristics of the fetus have been well covered by Wislocki (1925, 1926, 1927).

That sloths of this genus can swim has been noticed by many observers (Belt, p. 209). None were seen swimming, but one was found dead in the water, more probably having been thrown overboard from a passing ship than a victim of drowning.

After one half-grown individual had been found dead in the rising waters of Madden Dam and several others reported, a female with a young one was placed in the water. As she struck for the dock, the young one continued to hang on to the ventral surface, in which position it might have drowned, had they not been fished out. It is suggested that this may account for the number of immature specimens found drowned in the newly formed lake.

Sloths offer many opportunities for physiological research, particularly on the physiology of sex. The testes are intra-abdominal, and the interstitial cells are abundant (Wislocki, 1928, p. 359). Moreover, the male has a conspicuous mark upon his back, a secondary sex character, distinguishing him from the female. Castration and

transplantation experiments might contribute to our knowledge of sex physiology. The Two-toed Sloth has even more interstitial tissue and could be used as a check. The animals are fairly easily kept.

The external parasites of the sloth have been described frequently. "In *Bradypus griseus*, the duodenum invariably contains a quantity of nematode worms. These never have been found in *Choloepus* in the present series." (Wislocki, 1928, p. 341.) These parasites were identified by Dr. G. Stoener as *Leiuris decodontus*. Dr. Chapman saw a young Puma eating a Three-toed Sloth but could not determine how the animal had met death.

One individual, a male, fell a distance of five feet landing flat on his back; this resulted in death. Otherwise they are difficult to kill being resistant to ether and almost immune to systemic shock.

Two-toed Sloth

Choloepus hoffmanni

This large sloth is not seen very frequently on the Island, for its habits are such that it is easily overlooked. However, J. B. Shropshire supplied the laboratory with them in numbers, so they are not rare if one looks for them. On March 8, 1932, Shattuck brought in a mass of hair from remains he found in the forest between Shannon 5 and Wheeler, and Carpenter saw a large individual at Donato 3. Others have been seen from time to time.

While no observations were made in the field, many sloths were kept in captivity for periods of some length. They were fed on Cecropia leaves and the leaf of a herbaceous plant growing in moist places on the clearing. At Pedro Miguel, specimens have been kept for two years, while Wislocki and Richter transported several to Baltimore where they were kept for over a year. In each case, the sloths ate a wide variety of foods, including bananas, spinach, lettuce, carrots, potatoes, and other produce, so they do not present the difficulty encountered in attempting to keep alive the Three-toed Sloth.

This species is much more vigorous in self-defence than the Three-toed, moving the legs with great speed. Moreover, the dental armament is more formidable. It is not as pugnacious toward cage mates of the same or another species.

Twelve females were examined. Of this series two, taken in late December, were lactating and accompanied by young six hundred

to seven hundred grams in weight. Subsequent examination showed both females to be pregnant. This indicates that copulation may take place shortly after parturition. The other ten mature females which were examined between December and March were neither lactating nor gravid.

This sloth, too, is a swimmer. Individuals placed on a small island disappeared, probably swimming away across the same stretch of water covered by the howler and Cebus that escaped from the same place.

Two-toed Anteater

Cyclopes dorsalis

This small anteater is usually golden-yellow in color with a very soft, silky pelage — only one of the specimens secured being grayish with a very distinct dorsal stripe. Although not frequently seen, they are abundant on Barro Colorado as demonstrated by the number taken in the course of clearing the ground about the laboratory. They are strictly nocturnal and arboreal, they move slowly, nor do their eyes reflect the rays of the hunting lamp. Captive specimens spent the day and considerable portion of the night curled up in boxes built to imitate cavities such as are found in trees. For these reasons they usually escape observation until one comes across them during felling operations. The writer believes that, in dense forest such as is found over about half of the Island, they may average one to an acre. On the other hand, Shropshire, in a note concerning the capture of live specimens says . . . "they are rare. We usually get them asleep in the 'Zamia' patches in the mangrove swamps."

Captive specimens behaved differently from an individual of this genus described by Bates (1888, p. 178), for they never clawed out with the forepaws nor did they remain silent when irritated. In each case, a stick in the cage was firmly grasped with the hind feet, the body elevated into an upright position, the forepaws with the claws in resting position were pressed to each side of the face, and uttering a distinct hiss with each movement, the animal bowed time and again toward the disturber. That this is a usual reaction is shown by the fact that a mention of its name leads natives to imitate these movements, or an imitation of these movements is sure to elicit the animal's name. Van Tyne (1929, p. 314) reports somewhat similar behavior.

"The small anteaters, of which the smallest, Cyclura didactylus,

may serve as a good example, are arboreal. Their tails are long, with powerful flexor muscles, the action of which is increased by the existence of chevron bones opposite the bodies of the vertebrae. Cyclura has peculiar, but very efficient, grasping feet, especially well developed on the hind limbs. It lives among the small branches near the tops of high trees. It has a habit of grasping a branch with its hind feet, another with its prehensile tail, and upon the extensive tripodal base so obtained not only erects its body, but bows and sways to and fro, apparently for amusement. It probably often pursues the ants upon which it feeds by the same motion." (Reynolds, 1931, p. 283.)

The hind feet are so well developed that the erect posture can be assumed and maintained without any assistance from the tail. Moreover, it appears to matter little whether the toes are pointing forward or backward for when one is surprised the body may be raised with one foot in the normal position, toes to the front while the other is reversed or both may be reversed. The leg muscles of this species would repay anatomical study. The only food eaten by captives was termites, whole nests of which were placed in the cage. Nevertheless, no specimen lived more than eight days in captivity.

Mr. Zetek purchased a female, with a young one almost as large as herself, clinging to her, in early March. It is possible that the anteater has a breeding season in December and January similar to that of the Three-toed Sloth. One young is usually born (Wislocki, 1928, p. 71; Ryder, 1887).

The respiratory rate of a resting specimen was 27–28 per minute.

Three-toed Anteater

Tamandua tetradactyla chiriquensis

The Three-toed Anteater is both terrestrial and arboreal. It was found all over Barro Colorado Island as well as in the Forest Preserve, in the orchard of the Experimental Gardens, and in the tall guinea grass (*Panicum maximum*) of the pastures of the Cattle Industry. The anteater is essentially nocturnal, but is seen abroad at any hour of the day — at least on the Island. The eyes, which are small, reflect the rays of a hunting lamp, but are dull and difficult to see.

Of its food, Goldman (1920, p. 63) says, "an example brought in by a native hunter had at least a pound of ants in its stomach. These have been determined by Theo. Pergande of the U. S. Bureau of

Entomology and found to represent five genera, as follows: *Camponotus atriceps* Smith, *Dolichoderus bispinosus* Mayr, *Pseudomyrma pallida* Smith, *Aphaenogaster* —— sp.? and *Cremastogaster* —— sp.? Most of the ants were in a larval condition, but some were already winged." A young female shot by the writer contained one-half kilo of ant larvae, while another specimen had eaten somewhat less. As most of the specimens were taken alive and kept for some time, not many stomachs were examined.

They are easy to keep in captivity for they can be fed by placing nests of ants and termites in the cage. Termite infested wood is attacked and torn apart with powerful claws of the forefeet, and the tunnels emptied by the use of the tongue. This tongue is truly a remarkable instrument for it is capable of following a tunnel to its end, and then passing over to a parallel tunnel; the tip may clear it out by moving in the opposite direction from the base. This was observed on several occasions while holding dead branches and termite ridden papaya leaves from which an anteater was feeding.

There is a very characteristic odor which is similar to that of the urine. This is so strong that, after becoming familiar with it, one recognizes it in the forest. The dung, too, has a characteristic odor as well as appearance. It is always surrounded by a strong, impervious sheath that has the appearance of mucus and which holds the fecal matter in shape even when it is deposited in water, as it frequently is. In water the "sheath" absorbs moisture, becomes whitish, but does not disintegrate for several days. As to the source of this covering and its use, the writer can only speculate at present; later he plans to make a histological study of the colon and rectum and thus attempt to find an explanation. At present it can be said that this is mucus believed to be deposited about the feces as they pass through, or as they lie in the lower portions of the digestive tube and that, if in the anteater as in other Xenarthra such as the sloths, there is considerable storage of fecal material before defecation, this coat may prevent the absorption of decomposition products set free by undigested remains of a high protein diet.

On several occasions anteaters were found lying beside the highway passing through the Forest Preserve, victims of the new danger, the speeding automobile.

Lactating females were examined in November, December, and June, while half-grown young were seen in November and January, so there may be two breeding seasons or a continuous one. As in the sloths, the mammae are two in number and pectoral; the young

are carried on the ventral surface of the thorax. From the behavior and examination of a captive female, one might judge that they breed again about three weeks or more after parturition.

The anteater has a rather unusual nasal cry, somewhat like that of a suction pump when the liquid in which the intake is placed is so low that both air and liquid are taken up. This cry was uttered by a captive female, but it was not until it was observed time and again that the writer could be convinced of its source, for the sound was so unexpected. At first calls were attributed to hunger, but feeding did not stop them. Single calls were made at irregular intervals. Most calling was done between 5:00 P.M. and 6:00 P.M. Examination of the captive indicated that she was in heat. This call was heard in the forest on several occasions, always in the evening.

A half-grown individual was kept in captivity for some time. She became quite tame, even coming out of her box to be taken up. A series of rectal temperatures were made, but that did not frighten her, nor make her wild. Later she escaped by prying off a board that had been nailed against the supports on the inside of the cage and then enlarging the hole in the wire thus uncovered.

While this anteater is both terrestrial and arboreal, more are seen on the ground than in the trees. On the ground they move slowly walking with the claws of the front feet curled inward, a habit that results in a very characteristic track. They are clumsy walkers, and make considerable noise in moving about. When thoroughly aroused, they move at a gallop but are easy to overtake. When surprised on the ground, they make for a tree climbing rapidly and attempting to keep the trunk between themselves and observer. Frequently one will climb over a hundred feet upward to be lost in the maze of the forest canopy. Climbing is not limited to trees for they clamber over vines of small diameter and do much travelling and feeding in the masses of vines with which many of the forest trees are covered.

If it fails in an attempt to escape a pursuer, the anteater is very willing to fight. Two main methods of defense are employed, the one chosen depending on several factors. Either the animal lies on its back with all four feet in the air, or rearing up on its hind legs, it will assume what may be called the "tripodal posture." Regardless of which type of defense is utilized, considerable hissing and waving of the head accompanies it.

The effectiveness of the position with the four feet in the air is realized when an attempt is made to hold the animal down under a

board. In addition to clawing with the forepaws, the board edge is grasped and a powerful grip which brings the claws into play is applied, and, bringing into play the powerful muscles of the back and legs, the animal exerts considerable force on the board in the meantime squirming out from under it. Usually the bladder is emptied during the struggle and sometimes the animal defecates. How effective such a defense is the writer cannot say.

As soon as the fore part of the body is free the anteater rears it off the ground using the forearms with great effect. Once out from under the impediment, the animal assumes its most characteristic defense pose — the body erect, hind feet firmly planted wide apart, the heavy tail pointing out behind and pressed to the ground serving as the third leg of the tripod, the strongly armed forepaws ready for striking. The body is capable of extensive movement over the wide base thus established, and a surprising amount of force is necessary to destroy the animal's equilibrium. Unlike the giant anteater which, in this position, uses the tail as a counterbalance only, the Three-toed Anteater does not resort to a quadrupedal gait when it shifts position but can move with celerity in any direction without abandoning the erect attitude.

One female allowed herself to be driven backward a distance of two feet before a thrusting stick, until, by grasping the stick in her claws she jerked it from the writer's hand and then charged forward for six feet before stopping — all the while retaining her balance and the erect posture. Another individual charged with astonishing speed from this position, the body inclined forward, the right forepaw poised for a blow, the tail, during the charge, serving as a counterbalance but being pressed again to the ground as soon as the animal stopped and reassumed the erect position. Against the attack of what enemy does the anteater use this method of defense? The writer does not know but can vouch for its effectiveness.

Nine-banded Armadillo

Dasypus novemcinctus fenestratus

The only armadillo captured on the Island was picked up on a trail early one evening. Although not often seen, there are many on the Island, for tracks are seen everywhere and "workings" are numerous. Along the Chagres River, they are even more abundant and are frequently seen at night where some suffer, as do their kin in

Texas (Bailey, 1905, p. 56), when a disappointed deer hunter succumbs to the temptation to "get even" with one for the nervous strain imposed upon him by the rustling of leaves by an armadillo.

A captive specimen, an immature male, was tethered and taken into the forest to observe feeding habits. He plowed along with his snout in the loose litter on the forest floor, pausing from time to time to dig. It was impossible to determine what he was eating, but in all probability, all larvae, grubs and beetles found were eaten. When food was encountered he paused long enough to eat it, then hurried on. Doubtless the range of food eaten in Panama is no less than in Texas where "insects and other small life, including many species of grasshoppers, crickets, roaches, caterpillars, beetles, ants, spiders, centipedes, and earthworms" (Nelson, 1918, p. 223) are reported from examination of stomach contents.

While this specimen dug very rapidly in feeding, no attempt was made to escape by digging in. The claws of all four feet were used effectively in securing a purchase on the slightest projection of a perpendicular clay bank up which he chose to climb.

While in captivity, he spent most of the day coiled up under the litter in the cage, but rose from time to time to sniff the breeze, but the night was spent in attempting to escape, chiefly by unsuccessfully digging at the galvanized iron floor. He made a most unpleasant captive for the odor of the urine is very strong and offensive. This odor is encountered in the forest, and while similar to that of the urine of the Three-toed Anteater (*Tamandua*), yet it is characteristic enough to be specific.

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EXPLANATION OF PLATES

PLATE 1

PLATE 1

Map of Barro Colorado Island to show distribution of forests and clearings.

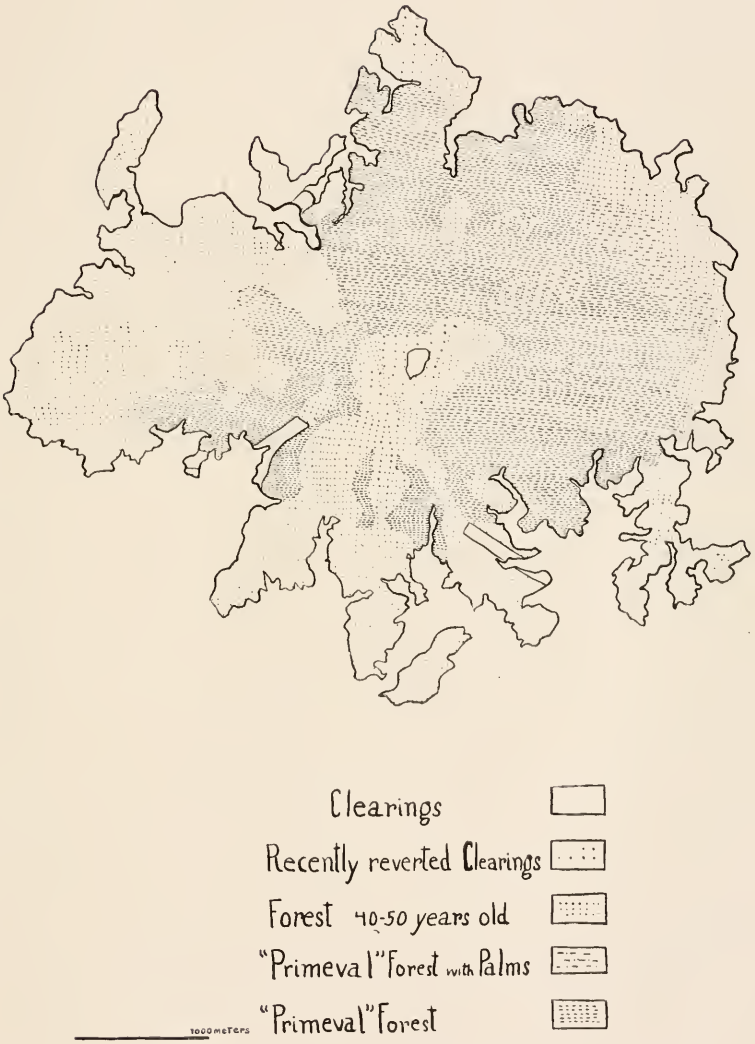
Clearings
Recently reverted Clearings
Forest 40-50 years old
"Primeval" Forest with Palms
"Primeval" Forest
1000 meters

PLATE 2

PLATE 2

Allen's Opossum

Metachirops opossum fuscogriseus

PLATE 3

PLATE 3

Top 5 figures. Isthmian Marmosa. *Marmosa isthmica*
Bottom right. Opossum. *Didelphis marsupialis etensis*
Bottom left. Woolly Opossum. *Philander laniger*

PLATE 4

PLATE 4

White-faced Monkey
Cebus capucinus imitator

PLATE 5

PLATE 5

Three-toed Sloth
Bradypus griseus

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